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No. 2.

COCCIDIOSIS OF FOWLS.

J. E. PETERSON, Veterinary Pathologist.

ALTHOUGH poultry of all ages are susceptible to coccidiosis, in practice its importance is largely as a disease of chickens from about three to twelve weeks old. Direct losses, through the death of infected birds may be very heavy. Further heavy losses may also be sustained, more indirectly, through retarded growth of chickens which recover from infection and through interference with the normal stocking programme of the farm.

The name "coccidiosis," covers a group of diseases which infect most kinds of animals and birds, all caused by small, single-celled organisms, microscopic in size, known as coccidia. However, these organisms are very host-specific, that is, they are capable of living only in one particular species of animal or bird, or, at the most, in a few very closely related species. Consequently, the poultry farmer need not worry about his chickens becoming infected through contact with other domestic birds such as turkeys or wild birds such as pigeons, which may frequent the fowl runs. It is possible however for these, and indeed, for the farmer also, to help disseminate the disease by the mechanical carriage of infective material from pen to pen, on their feet.

There are several species of coccidia capable of infecting the fowl, of which three or four may cause acute disease. The actual site of infection is in the wall of the gut, each species tending to infect a localised area. This results in two clinical manifestations of the disease (a) caecal coccidiosis (affecting the caeca or blind sacs near the lower end of the intestine) and (b) intestinal coccidiosis.

LIFE CYCLE.

Infection commences with the ingestion of matured oocysts by a susceptible bird. These oocysts are small, egg-like forms of the parasite, passed out in the droppings of a previously infected bird and when mature consist of eight small parasites protected by a thick shell. Upon entering the host bird, these parasites escape from their protective shell and enter the cells lining the gut wall. Here they rapidly increase in size, greatly distending and finally destroying the cells invaded. By a process of asexual reproduction each parasite gives rise to hundreds of others, which repeat the process after invading other cells of the host.

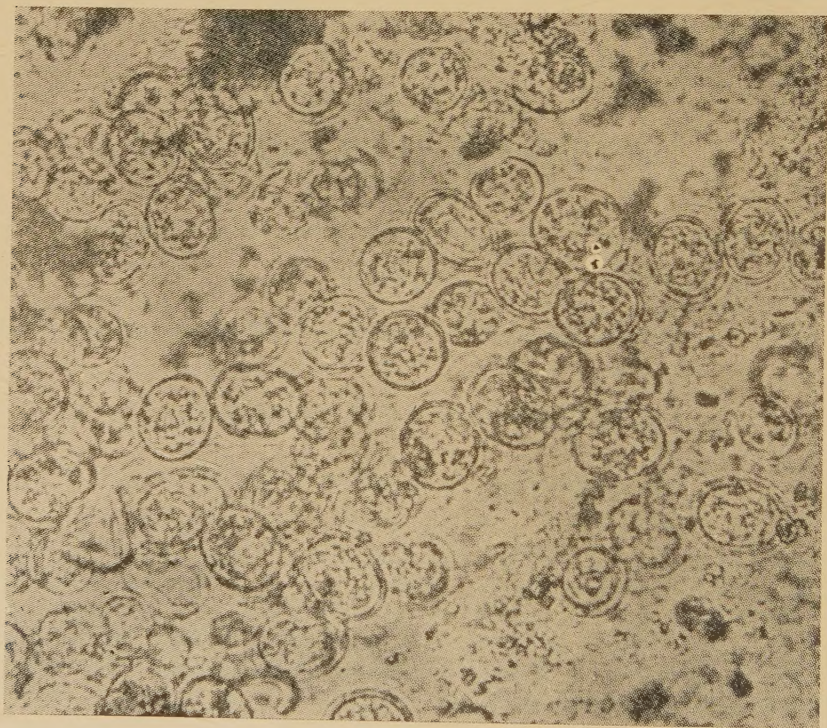


Fig. 1.—Microphotograph of droppings of a chicken suffering from coccidiosis. Large numbers of thick-shelled, egg-like oocysts are present.

(From N.Z. Dept. Agric.)

Eventually, after several generations of this type of reproduction the parasites differentiate into male and female forms. The latter, after fertilisation by the male parasites, form oocysts, which pass out in the droppings. When first voided the oocysts each consist of only one coccidium, protected by a thick shell and are capable of living for many months in shady, protected sites. In warm, moist conditions the oocysts mature by dividing into eight smaller parasites, all still protected by the outside shell. Under optimum conditions this final process of maturation, known as sporulation, takes about 48 hours after the oocysts are discharged by the fowl and once it has been completed, but not before this, the parasites are capable of reinfesting any fowl which ingests them. Thus the cycle of the parasite is completed, the time taken from the ingestion of sporulated oocysts to the development of the next generation of oocysts being four to seven days, depending on the species of coccidia.

TRANSMISSION.

Transmission of the disease, from bird to bird, under natural conditions, normally only takes place when living sporulated oocysts are present and are ingested by susceptible birds. The oocysts may reach the gut with food or water that has been contaminated by the droppings of infected birds or may be picked up by the beak whilst the birds are scratching contaminated ground or whilst preening themselves. Practically all poultry farms can be considered as having coccidia present to some extent. For clinical symptoms of disease to occur a certain minimum infective dose of coccidia must be ingested over a short period. Very slight infection, insufficient to cause symptoms, will result in the birds developing an immunity so that subsequent infestation will not result in the production of disease. Under conditions suitable to the parasite, however, a very heavy degree of infestation can be built up in a very short time.

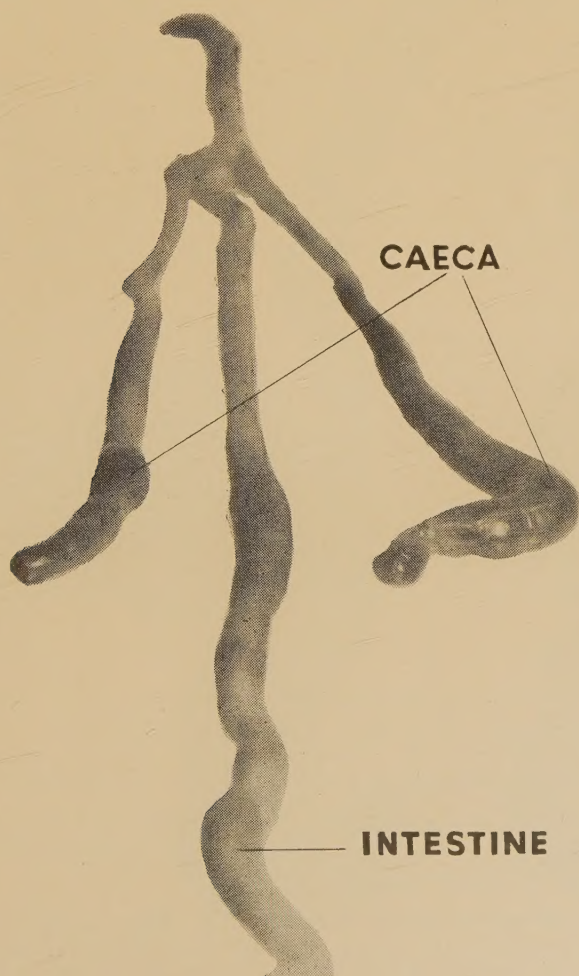


Fig. 2.—Caecal coccidiosis. Note both caeca enlarged and blood-filled.

In any poultry run there are places where droppings tend to accumulate, such as around feeding and drinking vessels, under perches or under brooders. When these droppings are heavily loaded with oocysts, birds coming in contact with them will soon pick up a very heavy infestation.

Even if the original contamination of a pen is only slight, it will be realised from the enormous numbers of oocysts which may develop from each coccidium that a few lightly infected birds may soon bring about progressively increasing contamination resulting in a rapidly spreading outbreak of disease.

It should be remembered also, that birds which have recovered from the disease may continue to excrete oocysts in small numbers for several months.

SYMPTOMS AND POST-MORTEM FINDINGS.

The symptoms of both caecal and intestinal coccidiosis are rather similar. Affected birds show a loss of appetite, appear depressed and stand with feathers ruffled. The number of birds so affected increases daily and within a couple of days of the first noticeable sickness deaths will commence in an acute outbreak.

In caecal coccidiosis blood will appear in the droppings in most cases. This is due to the action of the parasite on the wall of the caeca, causing erosion of the walls of the blood vessels in the area, with consequent haemorrhage. If affected chickens are opened, the caeca, or blind guts, will be found to be distended with blood, which may be clotted, or in less acute cases there may be cheesy plugs, with very little free blood. In most cases the site of infection is confined to the caeca, although in very severe cases it may extend a short distance up the intestine.

The picture in intestinal coccidiosis varies more than that of caecal infection. The upper two-thirds of the intestine is the usual site affected and in most cases this portion is rather distended and the intestinal wall thickened. On close examination the gut wall is seen to be studded with small greyish-white or red spots, about the size of a pin-head. The whole affected area may be very inflamed and often the intestine is filled with rather fluid, slimy material which may be greyish in colour or may be mixed with varying quantities of blood. However, many cases do occur, particularly in young chickens, in which the lesions are not very noticeable and may even be missed unless looked for carefully. Even when there is a considerable amount of haemorrhage present in the upper intestinal tract it is very seldom that recognisable blood is present in the droppings.

DIAGNOSIS.

Coccidiosis cannot be definitely diagnosed by symptoms alone, but in the majority of outbreaks, particularly if acute, a diagnosis can be made with a reasonable degree of accuracy from a consideration of the symptoms, history of the outbreak and post-mortem findings from the examination of several birds.

Even when such a diagnosis seems fairly certain it is desirable to have it confirmed by laboratory examination. Where there is any doubt it is even more important that a laboratory diagnosis be obtained.

When an outbreak is suspected several live, sick, or recently dead chickens should be forwarded to the Department of Agriculture, St. George's Terrace, Perth, as soon as possible, together with a letter giving full particulars of the extent of the outbreak, age of birds affected, symptoms, housing and feeding conditions and any other information considered relevant.

PREVENTION.

Prevention of outbreaks of coccidiosis is based on a knowledge of the above facts concerning the life cycle of the parasite and the mode of infection.

As soon as the chickens are placed on previously used runs they will commence to pick up oocysts and will soon be excreting them in their droppings. As the oocysts are incapable of re-infecting the birds for about 48 hours it will be clear that if the pens and yards are cleaned every 24 hours the risk of heavy re-infection will be largely eliminated. If, in addition to this, the feeding and drinking vessels are protected from contamination by droppings the maximum degree of infection occurring should be insufficient to produce symptoms but sufficient to produce immunity.



Fig. 3.—Intestinal coccidiosis. Note distention of loop of intestine and dark colour due to inflammation and haemorrhage. Numerous small haemorrhages are also present on the surface of the intestine and are visible as small, dark spots. Both ends of the intestine are normal and not infected by coccidia.

It is possible to keep the birds free of infection by rearing them on raised wire-mesh floors, so that there is absolutely no contact with droppings or with previously contaminated floors. This course is not recommended as a preventive measure as the birds remain fully susceptible and will pick up the disease as soon as they are taken off the wire.

As sporulation of the oocysts, which must occur before they are infective, only occurs in moist conditions, then if the runs are kept dry the amount of infective material present will be greatly reduced. This means that when runs containing birds are cleaned, the floors should not be moistened. Care should also be taken to see that water from drinking vessels cannot spill or leak onto the floor.

Brooder runs should not be used for any fowls except young chickens. If the runs are grassed this should be kept short for as much of the year as possible as long grass, especially if moist, provides ideal protection for oocysts, which are not particularly resistant to prolonged drying or direct sunlight.

If an outbreak of coccidiosis has occurred it is desirable to disinfect the brooder house and runs before a fresh batch of chickens uses them. The usual types of disinfectants should not be used as they have practically no effect on the oocysts. Neither can the use of a blow-lamp flame be recommended to disinfect floors as it has been shown that it is only effective after prolonged application.

The two effective disinfectants are (a) household ammonia (10 parts ammonia to 100 parts of water) and (b) caustic soda (1 lb. caustic soda to 20 gallons boiling water).

Before attempting to disinfect, the floors should be thoroughly scraped clean and swept.

The feeding of sulphaguanidine in the mash is effective in preventing the disease provided the feeding commences before the birds become exposed to infection. This treatment may be of some use where it is known that the flock cannot avoid exposure to heavy infection, but is obviously of limited use.

TREATMENT.

If an outbreak of coccidiosis develops it is essential to immediately commence treatment on a flock basis. At present the most efficient treatment is sulphamezathine (sulphamethazine). Several other of the sulphonamide drugs can also be recommended. Details of this treatment are given below.

Apart from these sulphonamides there are very few drugs which have any marked effect on the course of the disease, once it has become established, although very many have been recommended from time to time.

Whatever drugs are used it is still essential that the control methods set out above under "prevention" be also carried out. In addition, any birds dying should be destroyed by burning.

Treatment should commence as soon as possible if heavy losses are to be prevented.

Sulphamezathine.

This drug should be administered after an outbreak has commenced and has the advantage that whilst it is spectacular in stopping losses it does not interfere with the production of immunity. It may be administered either through the mash or through the drinking water. The latter route is the more satisfactory. The drug may be purchased as a 16 per cent. solution of sodium sulphamezathine. This is given at the rate of 2 fluid ounces per gallon of water. All other water is withdrawn. The medicated water is given for four days. It should not be given more than seven days, at the most, as it is then likely to produce toxic effects. In a four day period 100 chickens one month old will drink about 6 gallons of the sulphamezathine treated water, while 100 chickens three months old will drink about 9 gallons.

Other¹ sulphonamides.

Sulphapyrazine can be used in a similar manner to sulphamezathine, but at a slightly lower concentration (1 oz. per 6¼ gallons water). It has certain advantages over sulphamezathine but at present is difficult to obtain and much more expensive than the latter.

Sulphamerazine, fed through the mash, gives good results if fed very early in the disease, and could be used if sulphamezathine is unavailable.

If none of the above drugs are available sulphaguanidine, fed at the rate of 1 per cent. in the mash could be tried, but results would not be as satisfactory as those obtained from sulphamezathine.

SUMMARY.

Coccidiosis is principally an acute disease of chickens from three to twelve weeks of age, although birds of all ages may be susceptible.

Transmission of the disease is by ingestion of oocysts which have been voided in the droppings of infected or carrier birds. The oocysts require a minimum of about 48 hours to mature and become infective. They may remain alive in yards for many months.

Symptoms and post-mortem findings are described. Two forms of the disease occur (a) caecal, in which blood is commonly found in the droppings and (b) intestinal, in which blood is seldom seen in the droppings.

Coccidiosis can be prevented by keeping birds from contact with droppings or surfaces contaminated by these. The severity of the disease is directly proportional to the number of oocysts swallowed.

A very slight infection will produce an immunity without producing symptoms of disease.

Household ammonia and caustic soda are effective disinfectants against the oocysts.

Sulphamezathine is the drug of choice to combat an outbreak of the disease.

ALBANY AGRICULTURAL AND HORTICULTURAL SOCIETY PASTURE AND MEADOW HAY COMPETITIONS, 1949-50.

By C. T. E. SAGGERS.

THIS is the third year that the Albany Agricultural Society has conducted a Pasture Competition. As in 1947-48, this competition included all pasture on the farm.

Two judgings had been arranged; one between 26th November and 4th December, the second to be early in February to assess the perennial value of the species present. Owing to unavoidable delays, the first judging was a little late, but similar conditions affected all competitors who were all most helpful in showing their pastures and explaining their management systems.

Seasonal conditions had been good during the early and mid-spring weeks, but an abrupt cessation of rain had a somewhat adverse effect on some pastures. The final judging in mid-February, after a long dry spell, showed the pastures in a different aspect.

The points awarded to each entry are shown in the following table:—

Competitor.	Density and Even- ness of Sward. 60	Absence of Weeds and Insect Pests. 25	Botanical Composi- tion. 40	Manage- ment. 75	Total. 200
B. P. Zimmermann, Torbay	54	23	36	72	185
R. B. Wilkinson, King River	50	24	38	72	184
F. Pease, Torbay	55	20	36	68	179
L. Joyce, "Barretts Meadows," Albany	50	23	35	66	174
Farr Bros., Torbay	54	20	34	65	173
L. Jordan, Napier	54	20	33	65	172
Haldane & Son, Porongorups	45	18	30	65	158
A. Gale, Upper Kalgan	48	22	32	55	157
C. D. Astill, North Napier	50	22	30	45	147

B. P. Zimmermann—Torbay.

This property of 263 acres is subdivided into 16 paddocks, and has 103 acres of pasture. This showed an excellent botanical balance, consisting as it did of mid-Season Subterranean, White Dutch and Drooping Flower Clovers, with perennial Rye Grass, Kikuyu and a little Yorkshire Fog grass. An excellent stand of Subterranean and Drooping Flowered Clover was noted on an area of newly cleared land. A strict system of rotational grazing is carried out with extensive renovating as needed. Top-dressing is carried out in two operations. One bag per acre in autumn, half bag per acre in the spring. All new pasture is sown down with copperised super at the rate of one bag per acre. Maize is grown very extensively.

Stock consists of 29 milking cows, six dry stock, one bull and two horses.

This is a particularly attractive property, well laid out and in excellent order and condition.

R. B. Wilkinson—King River

With a total area of 850 acres of Jarrah Redgum country with a large Bottle-brush flat, this farmer has laid down 200 acres of high class pasture. The old pasture shows excellent management, but the new land results were somewhat uneven, and typical of either excess water or some minor deficiency. An excellent pasture mixture consisting of Lotus Major, Strawberry, White Dutch and Montgomery Red Clovers, Paspalum, Yorkshire Fog and Kikuyu was noted on the wetter land with some very good stands of mid-season Subterranean Clover and perennial Rye Grass on the higher paddocks. Weed control is good.

This property is subdivided into 24 paddocks and an excellent system of rotational grazing and renovation is carried out. Top-dressing is varied according to the needs of the pastures; wet ground receiving two bags per acre and new and dry land $1\frac{1}{2}$ bags per acre, with a special amount of 17 lb. of sulphate of ammonia per acre on a selected area of summer land.

Stocking consisted of 31 milking cows, 22 dry stock and two horses.

F. Pease—Torbay.

Of a total area of 110 acres of good quality jarrah-redgum country, 75 acres of high class pasture has been sown down.

Pasture is composed of Subterranean Clover, Drooping Flowered Clover, with a little Lotus Minor plus Kikuyu, Wimmera Rye and Yorkshire Fog. This is supplemented with heavy summer crops of maize, etc, plus ensilage. Some weeds in evidence, principally docks, sorrell and a little flat weed.

Subdivision is Good.—Seventeen paddocks are provided and used in a rotational grazing system. Renovating is carried out as required. Top-dressing is carried out in one operation in the autumn, one bag per acre on old pasture, two bags per acre on new land.

Stocking consists of 30 milking cows and 10 dry stock.

L. Joyce—Barrett's Meadows, Albany.

This property consists of two blocks of a total area of 332 acres. Pasture is established on the home farm and consists principally of mid-season Subterranean Clover, Lotus Major and Minor, Drooping and White Dutch Clover, plus Perennial Rye, Cocksfoot, Paspalum, Kikuyu and some Yorkshire Fog. No renovating is carried out but all paddocks are grazed in rotation during Autumn, Winter and Spring. Weed control is very good. Top-dressing is at the rate of 200 lb. per acre with an additional spring application for hay. Two acres of maize is grown.

Stock consists of 13 milking cows and eight dry stock, all of which were in excellent order. An attractive property being built up to high standards.

Farr Bros—Torbay.

These farmers carry out their operations on two properties, consisting of 201 acres and 160 acres, with 197 acres and 57 acres respectively of pastures. Pasture species are principally Subterranean Clover with Wimmera and Perennial Rye grass, also some Lotus Minor, Yorkshire Fog and minor grasses. Approximately seven acres have been plated with Kikuyu grass and an area of second

season pasture showed dense growth where sown on the burn. No pasture renovation is carried out but rotational grazing is consistently practised. Top-dressing is at the rate of one bag per acre with some increase on hay paddocks. Weed control was reasonably good. Some docks and rushes were noticed.

Stocking consists of 47 milking cows and 25 young stock.

L. Jordan—Napier.

This farm consists of 335 acres of nicely sloping jarrah-redgum country with 40 acres of totally cleared pasture and 90 acres part-cleared. Pasture consists of Subterranean Clover, Wimmera Rye, Yorkshire Fog and a little Kikuyu. Oats are also grown for early feed. Some docks and bracken are in evidence. Sub-divided into 11 paddocks, this property shows a progressive policy and was in very fair order.

Stock consisted of 21 milking cows and 24 dry stock.

Rate of fertilising was one bag per acre in one operation.

Haldane and Son—Porongorups.

On a total area of 400 acres of land timbered principally with jarrah-redgum, yate and paper-bark, an area of 230 acres of pasture has been sown down. Species included Subterranean Clover, Drooping Flowered Clover, Suckling Clover, Wimmera Rye and approximately five acres have been planted to Kikuyu. Some silver grass was showing in back paddocks and docks were in evidence in drains and wet hollows. Sub-division consists of 15 paddocks. Stocking consists of 30 head of milking cows and 14 dry stock. Top-dressing at the rate of one bag of superphosphate per acre is carried out annually in one operation during autumn and early winter.

A. Gale—Upper Kalgan.

Of a total area of 100 acres of heavy loam hillside and blackboy flats, 40 acres have been sown to pasture. Principally Tallarook Subterranean Clover, with *Phalaris Tuberosa* doing well in one paddock, and some scattered Cocksfoot and Perennial Rye. Sub-divided into seven paddocks, this property shows promise of development. An irrigation system is just coming into use, and full benefit has not yet been felt. Electric fencing is used for rotational grazing. Weeds were fairly well-controlled. Stock consists of 14 cows, eight heifers and four dry stock. Top-dressing rate is 2½ cwt. for hay, 3 cwt. on irrigation area, balance one bag per acre.

C. D. Astill—North Napier.

An attractively situated property of 160 acres with approximately 65 acres of pasture on typical jarrah-redgum country, with small patches of yate, consisting principally of Subterranean and Drooping Flowered Clover. This pasture is lacking in blade grasses, and an effort has been made to counteract this by planting Kikuyu. Some Cape-weed was in evidence, otherwise weed control was good. Fertilising was as follows:—Four cwt. per acre on three acres clover for

hay and seed, 3 cwt. on 20 acres for hay, balance at one bag per acre. A very noticeable difference could be seen between the lighter dressing and 3 cwt., but very little difference in growth could be seen on the 4 cwt. area.

Stock consisted of 11 cows, 10 dry stock, 35 sheep and two horses.

MEADOW HAY COMPETITION.

The points allotted to each entry are shown in the following table:—

Competitor.	Botanical Mixture.	Type and Palatability.	Time of Cutting.	Aroma.	Amount per Cow.	Total.
	20	30	25	10	15	100
F. Pease, Torbay	20	24	24	9	12	89
R. B. Wilkinson, King River	18	25	23	9	12	87
B. P. Zimmermann, Torbay	18	24	24	8	10	84
Farr. Bros., Torbay	18	22	22	7	9	78
Haldane & Son, Porongorups	20	20	18	7	9	74
C. D. Astill, North Napier	16	18	22	6	9	71

F. Pease—Torbay.

The hay on this property was of very high quality, of exceptionally good colour and aroma. The botanical composition showed an excellent balance between legumes and blade-grasses. The quantity conserved was ample, but had also been augmented by a stock of silage and crops of maize.

R. B. Wilkinson—King River.

This competitor had a very good entry, showing excellent colour and aroma. Botanical composition showed slight dominance of subterranean clover. Amount conserved should be ample as this property carries excellent summer grazing.

B. P. Zimmermann—Torbay.

The hay was of good quality and of good colour. Botanical composition good. Amount conserved should be sufficient, if augmented by large area of maize as planned.

Farr Bros—Torbay.

This was an attractive lot of hay, somewhat spoilt by weathering, but of good colour and fair aroma. Botanical mixture was good. The amount conserved is a little light compared with the leading competitors.

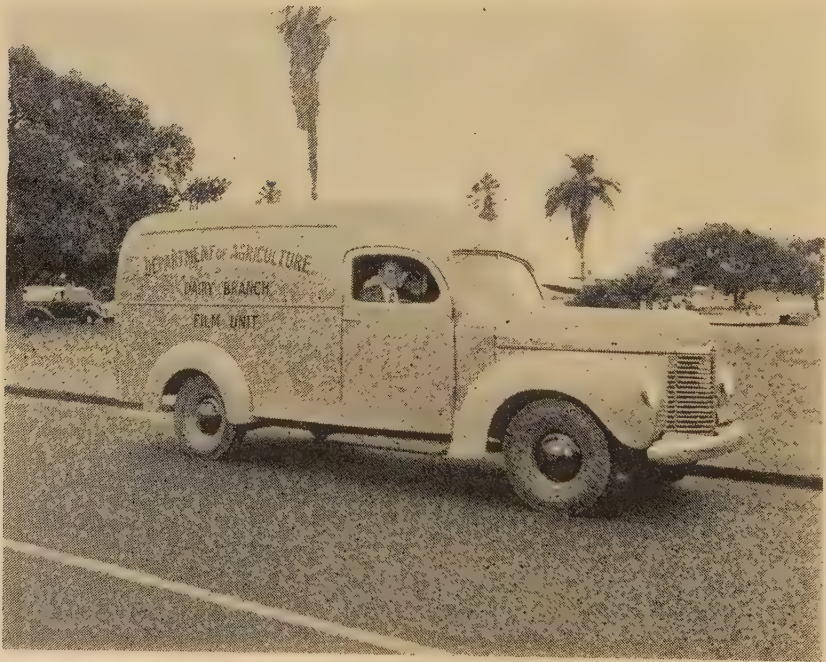
Haldane and Son—Porongorups.

The botanical composition of this hay was good, but delays in cutting had affected colour and aroma to some extent. Amount conserved should be sufficient. The species included and baling methods etc., would have earned this competitor high marks were it not for delay in cutting some portions.

C. D. Astill—North Napier.

This hay was of very high subterranean clover content, insufficient grasses being included. This was unavoidable as the area cut was to be harvested for seed. Colour was very fair, and aroma was spoilt by weathering whilst waiting for contract baler.

MOBILE FILM UNIT—DAIRY BRANCH.



TOWARDS the end of 1948 it was decided to establish a film unit for the Dairy Branch of the Department of Agriculture to be financed from funds available under the Special Commonwealth Grant to the Dairy Industry.

Many initial difficulties were encountered in respect to the supply of essential equipment, but ultimately a self contained unit was ready for the road early in April, 1949. The unit consists of a 16 m.m. sound projector which can be utilised either on the metropolitan electricity supply, certain country supplies or, where no power is available, it may be operated from a generator carried in the van. As the unit is independent of local power supplies it is possible to arrange screenings in any locality.

The value of visual education has long been recognised and it is hoped that by means of this film unit it will be possible to put before the dairy farmer in a pleasing and entertaining way the most recent developments in Dairy Research throughout the world. The object of the film unit is essentially educational and it is not intended to provide an evening's entertainment. It is hoped to be able to screen at one show, one feature film and a number of supporting films of shorter duration of interest to agriculture generally and dairying in particular.

At all of these screenings the Field Officer of the District will be in attendance and will discuss not only the film but any other matters of interest connected with the district.

Many of the films which are available in the dairy branch library have been produced in America or Great Britain and, whilst it is realised that in some matters of detail certain aspects are not applicable to local conditions, the general details will be of value to all farmers. However, a start has been made on the production of a film under local Western Australian conditions and it is hoped that this film "Dairy Farm Management," in technicolour, will be available for screening before the end of 1950.

Many requests have been received from all parts of the State for screenings by this unit but in order to effect proper economy of running it is necessary to arrange planned itineraries in specific areas and to date these have been finalised by co-operative arrangements between the Field Officer and local Farmers Organisation.

Publicity for the screenings is arranged by means of the wireless and the press, but any organisation is invited to submit a request for a screening and this will be included in the appropriate itinerary in due course.

Dairy Farmers are particularly requested to consider these film evenings as a discussion group as it is felt that equal value will be obtained from discussion after the film as is likely to result from the actual viewing of the show itself.

The following films are available in the Dairy Branch Library and a number of others are on order:—

"Science of Milk Production."

"More Milk."

"Bip Goes to Town."

"Block That Termite."

"The Life of Plants."

"Wizard Svalof."

"Feeding Farm Animals."

"John Martin & Son."

"Battling Brucellosis."

"Conveying and Measuring Irrigation Water."

"Quality of Milk Production."

"Red Terror."

"No Hand Stripping."

"The Milky Way."

"Preparing to Irrigate."

"Aberdeen Angus."

"Breeding for Milk."

"Library on Wheels."

"Killing Farm Rats."

"Richer Than Butter."

"Ayrshire Cattle."

"Welding Helps The Farmer."

Whilst the above are for screening by the Mobile Film Unit a number of Wool Board films are available for loan to Farmers' Organisations possessing their own projection equipment. The only requirements necessary are that these should be screened by a licensed 16 m.m. projectionist and returned to the Department in an unwound condition.

The Wool Board films are—

“Foot Rot and Foot Abscess.”
 “The Blow Fly Menace.”
 “Hidatids.”
 “Branding.”
 “Control of Worms in Sheep.”
 “The Larger Stomach Worm.”
 “Shearing Hygiene.”
 “Scabby Mouth.”

“Vaccine and Vaccination.”
 “Pioneer Stud.”
 “Fences.”
 “Shearing at Billabong.”
 “Mules and Tail Operations.”
 “Ram Sales.”
 “Mineral Deficiencies.”
 “Drought Feeding.”
 “Fabrics of the Future.”

WATERS FOR AGRICULTURAL PURPOSES IN WESTERN AUSTRALIA.

By Officers of the Department of Agriculture and the Government Chemical
Laboratories.

WATER FOR STOCK.

THE nature of water which stock will drink varies greatly with circumstances and conditions. In this State the variation between the summer and winter salinity of the same water supply may be very great, and if stock have been accustomed to watering from one source, the gradual increase of salinity which occurs with increasing summer concentration may pass unnoticed by the animals, who become accustomed to it and suffer little ill effects. If, however, stock which have been accustomed to drinking fresh water, are suddenly put on to a very salt supply, it may be quite distasteful to them, and they may either refuse to drink it or suffer ill effects from its use. Stock, if thirsty through travelling, or under extreme conditions may take and thrive for a short period on a very saline water from which they would suffer if used continuously.

Such factors as these make the question more complicated than at first appears, and although certain standards of composition are recorded, their application cannot be entirely rigid. Water containing less than 300 grains total salts per gallon can be used continuously by all farm livestock. Sheep can tolerate water which is much more saline than that suitable for cattle, and cattle are more resistant than horses and pigs.

The standards at present in use in this State as the safe upper limits of total salts in water for stock are:—

	Grains per Gallon.						
<i>Poultry</i>	..	..	..	..	..	..	200
<i>Pigs</i>	..	..	..	..	..	..	300
<i>Horses</i>	..	..	..	..	..	..	450
<i>Cattle (Dairy)</i>	..	..	..	..	..	..	500
<i>Cattle (Beef)</i>	..	..	..	..	..	..	700
<i>Adult Dry Sheep</i>	..	..	..	..	..	..	900

(437.5 grains = 1 oz.)

These total salts include common salt (sodium chloride), gypsum (calcium sulphate), Epsom salts (magnesium sulphate), Glauber's salts (sodium sulphate) bicarbonate of soda, lime, and magnesia.

In the agricultural areas of Western Australia about three-quarters of the total salts is common salt. The proportion of common salt is less in the pastoral areas and the northern part of the State.

When the total salts exceed these amounts, only practical tests will show whether the water can be used without ill effects, because varying conditions vary the allowable maximum amount of soluble salts.

Where green feed is available, the animals can tolerate more saline water than when "bush or scrub" is the only feed. Sheep have been known to live on water containing up to 1300 grains per gallon of total salts for short periods, but success cannot be forecast with water so saline. Further, older and dry sheep can tolerate waters more saline than can young, growing sheep (weaners) or breeding ewes, and similarly for other stock. Lambs, weaners and ewes in milk should be kept under observation if drinking water containing more than 700 grains of total salts per gallon. Horses not at work can be kept alive on a more saline water than can horses at work.

As indicated in the table, dry or beef stock can tolerate a more salty water than can milking cows. However waters with much less salts than the maximum of 500 grains per gallon given in the table will reduce the milk production of high yielding cows.

Although a water may be too saline for use alone, it may be mixed with good water to lessen the drain on the good supply, e.g. when water carting is necessary. The proportions for mixing can be calculated from the soluble salts content of the two waters.

Mixing with a fresh water is the only practical and economic method at present available for utilising saline waters.

WATER FOR IRRIGATION.

The use of water for irrigation and domestic gardens is influenced not only by the amount of saline material dissolved in the water, but also by the type of soil and drainage, the climate and the rainfall. Much of the unsuitability of saline waters is due to the accumulation in the soil of the salts from the water applied.

The following remarks should therefore be taken only as a general guide, and it is emphasised that where the waters approach the maximum salinity for particular plants or where there exists special conditions of drainage, soil types, rainfall, etc., only practical tests will indicate the suitability of the water for the use in question. A more saline water can be used successfully on a well-drained light soil, than on a poorly drained heavy soil. Similarly a more saline water can be used in districts of high, though seasonal, rainfall, as the rain washes down the salts accumulated in the soil.

In general, where the drainage is good, water containing up to 70 grains total salts per gallon is suitable for growing all types of plants, including the salt susceptible plants.

Water containing *up to 150 grains* total salts per gallon, is suitable for growing most *plants other than those susceptible to salt*. Water containing *up to 220 grains* total salts per gallon, has been used for growing tomatoes, lucerne and cabbage and other *salt resistant plants*.

Above these limits, care should be taken to observe closely the growth and condition of plants or herbage, and if considered necessary, to obtain advice from the officers of the Department of Agriculture.

Generally, however, 220 grains of total salts per gallon is regarded as approaching the maximum for safe watering of any plants. With such salt content, the drainage should be excellent and each watering should be of sufficient quantity to leach accumulated salts to a level below the root zone.

In the case of nearly all underground waters, it is advisable to apply by furrows or by flooding rather than by sprinkling.

Where irrigation is not continuous, i.e. if the water is applied very infrequently, or only for short periods during the year then a water rather more saline than the above standards can be used.

Salt Tolerant Plants.

Asparagus, beetroot, cabbage, cauliflower, celery, couch grass, cucumber, lucerne, mangels, melons, pumpkins, rhubarb, silver beet, tomatoes, Wimmera Rye grass.

Salt Susceptible Plants.

Apricots, carrots, citrus, French beans, grape vines, maize, parsnips, peach, peas, potatoes, radishes, and seedlings.

There is no sharp, clear-cut dividing line between suitable and unsuitable water for either plants or animals. Just as plants and animals may under favourable conditions continue to live with waters more saline than the figures quoted, so growth and production will in general decrease as the salinity of the water approaches the various upper limits quoted.

GENERAL.

1. For general domestic use and for human consumption on individual farms the safe upper limit of total soluble salts is considered to be 150 grains per gallon. The water should be clear, colourless and odourless and free from pollution or contamination by organic matter.

Water containing up to 300 grains per gallon may be used for showers and baths especially if a salt water soap is used, and water containing up to 700 grains per gallon may be used in a septic tank system.

2. Natural waters may be acid (sour) (like diluted lemon juice or vinegar) or alkaline (like a weak solution of washing soda) or neither, that is, neutral.

3. Acid waters have a rapid corrosive effect on iron, such as pipes and tanks, and acidity should be corrected by the addition of good quality builders lime, the quantity depending on the degree of acidity. The required amount of lime should be mixed to a thin milk with water and this milk mixed thoroughly with the bulk of the water. It is advisable to allow time for any solids in the water to settle out before drawing off clear water. After liming it is desirable to aerate the water (by splashing) before use to remove any excess of lime. The lime may be added direct to a well.

Limestone may be used instead of builders lime but takes longer to act. The limestone can be placed in the well, for example as a cairn around the end of the intake pipe, or may be hung in a perforated bucket under the pipe entering the tank.

4. Acid waters may contain iron in solution and the addition of lime to correct the acidity will throw this iron out of solution as a sludge, which should be allowed to settle and the clear water used.

Waters containing iron compounds in solution may be clear and colourless when first drawn but become cloudy or deposit brownish yellow iron rust on standing, due to the action of the oxygen of the air on the iron compounds.

5. Water may contain hydrogen sulphide (sulphuretted hydrogen) a poisonous gas with a very objectionable odour similar to that of rotten eggs. This gas can be removed by aerating the water, the most convenient method usually being to allow the water to splash freely into the tank, e.g. by using a splash board under the pipe entering the tank.

6. The clearing of muddy water by settling can be assisted by the use of kopi, powdery gypsum, at rates up to 4 lb. per 1000 gallons of water, or by the use of good quality builders' lime at rates up to 4 oz. per 1000 gallons. If kopi is not available, plaster of Paris, well stirred with 10 times its weight of water may be used. If the water is a good one then common salt may be used to assist clearing, remembering that adding 1 lb. of common salt per 100 gallons of water adds 70 grains per gallon to the total salts present.

7. The salinity of ground water, particularly surface or shallow supplies, may change with time. It is not possible to forecast whether such change will occur, or whether the salinity will increase or decrease except that frequently there is an increase in salinity as the summer advances and a decrease during winter.

Samples of water for stock, irrigation and domestic purposes, are analysed by the **Government Chemical Laboratories, Adelaide Terrace, Perth**, on compliance with the following:—

A. Each sample should:—

- (a) Be approximately one pint of water in a clean container which has been previously rinsed with the water to be tested.
- (b) Be clearly marked with the sender's name, address and date of sampling.
- (c) Be securely packed and addressed to the **Government Chemical Laboratories**.

B. At the same time, a letter should be forwarded stating:—

- (a) That the applicant is a bona fide farmer, market gardener, grazier, etc., and that the analysis is required in connection with his business as such;
- (b) The source of the sample e.g. bore, well, spring, etc., and its depth, and the location number of the property from which the sample was obtained.
- (c) Enclosing the fee of 7s. per sample. This fee applies only to those who qualify under paragraph B (a) otherwise the fee is £1 1s. per sample.

Should the analysis be required very urgently, this should be stated in the letter and the cost of a telegram added to the fee, when a telegram will be sent immediately the analysis is completed.

RATE OF MILKING WITH MACHINES.

Further Results from Western Australian Herds.

R. A. BETTENAY, Agricultural Adviser.

IN an earlier article by this Department (Vol. XXVI No. 2 pp. 99-104) some introductory remarks were made on a study being conducted on the rate of milking by machine, and preliminary findings were recorded. The conclusion was reached that the rate of milking on most farms was too slow, it being considered that in the vicinity of five minutes per cow should be sufficient under machine milking and that, if the teat cups were left on for a longer period than this, damage to the udder was likely to follow.

The present article records the results of a further study to determine (a) the influence of the number of units per operator (b) average milk produced per cow on the rate of milking. All Grade Herd Recording Units operating in 1949-50 were included and the five-monthly period from June to October, 1949 was considered.

In this study number of units per operator (i.e. number of units in milking machine in use, divided by number of personnel employed in the shed) was taken as one of the variables to give an indication of efficiency of operation and perhaps of the optimum number of units per man.

A few herds where the average time per cow was abnormally large—in the vicinity of 15 minutes—were excluded from the averages as probably some other factor such as feeding in the bails was limiting in these cases.

Results of the study are set out in Tables 1A and 1B, Table 1A consisting of those herds stripped by machine and Table 1B of those herds stripped by hand. Figures in the bulk of the table represent the average time taken per cow in minutes, and in brackets the number of herds on which the average is based.

TABLE 1A.
AVERAGE TIME OF MILKING (MINS.).

Machine Stripping—June-October, 1949.

No. of Units.				Average Production (lb. per day).					
No. of Operators.				Less than 15 lb.	15-20 lb.	20-25 lb.	25-30 lb.	Greater than 30 lb.	Weighted Average
1	....	....	....	7.00 (10)	6.52 (24)	6.83 (53)	7.89 (28)	7.25 (8)	7.05 (123)
1½	....	....	....	8.08 (3)	8.10 (22)	8.02 (72)	8.33 (37)	7.77 (26)	8.06 (160)
2	....	....	....	7.22 (30)	7.58 (93)	7.50 (177)	7.63 (121)	8.02 (45)	7.58 (466)
3	....	....	....	8.71 (12)	8.34 (43)	8.68 (82)	8.31 (81)	9.45 (22)	8.57 (240)
4	....	....	....	10.75 (6)	9.99 (19)	9.77 (35)	9.92 (20)	9.25 (7)	9.88 (87)
Weighted Average				7.86 (61)	7.90 (201)	7.92 (419)	8.10 (287)	8.27 (108)	8.00 (1076)

TABLE 1B.
AVERAGE TIME OF MILKING (MINS.).

Hand Stripping—June-October, 1949.

No. of Units.				Average Production (lb. per day).					
No. of Operators.				Less than 15 lb.	15-20 lb.	20-25 lb.	25-30 lb.	Greater than 30 lb.	Weighted Average
1	....	....	....	6.39 (7)	6.46 (32)	7.06 (85)	6.87 (88)	7.59 (29)	6.96 (241)
1½	....	....	....	7.25 (2)	7.61 (18)	7.87 (56)	8.28 (47)	8.76 (37)	8.16 (160)
2	....	....	....	8.21 (13)	7.32 (63)	7.87 (122)	8.35 (136)	7.98 (60)	7.98 (394)
3	....	....	....	....	9.19 (8)	8.80 (27)	9.41 (31)	8.70 (19)	9.07 (85)
4	....	....	....	....	8.25 (1)	9.00 (2)	9.86 (9)	9.55 (10)	9.57 (22)
Weighted Average				7.55 (22)	7.27 (122)	7.73 (292)	8.07 (311)	8.29 (155)	7.88 (902)

All herds with a ratio of units per operator which did not fit into the classification shown in the tables—e.g. 4 units, 3 operators; 5 units, 1 operator; 5 units, 2 operators—were excluded from the study as their numbers were too small to warrant further divisions being included.

It is of passing interest to observe that slightly less than half (903 out of 1878) or 45.6 per cent. of the herds studied were hand-stripped. More herds are hand-stripped in sheds where an operator has a small number of units to attend and less are hand-stripped where an operator is attending to 3 or more units. This suggests that certain farmers have abandoned hand-stripping simply because labour is not available and perhaps intend to recommence hand-stripping as the labour position eases.

A comparison of Tables 1A and 1B shows that there is no significant difference in time taken to milk under machine stripping and hand-stripping. This is a matter for some concern as it reflects on the efficiency of machine milking as practised in this State. Evidently many farmers who have discarded hand-stripping in favour of stripping by machine have adopted the practice of leaving the teat cups on the udder for a considerably longer period than is necessary in order to "make doubly sure." The recommended practice when milk flow is ceasing is to pull down on the teat claw and massage the udder towards the teats for a short time to drain the udder and then to remove the cups before damage to the udder tissues results.

Comparison of Milking Time in Various Production Groups.

To determine the influence, if any, of average production of the herd on time of milking, it is necessary to compare within each ratio group in Tables 1A and 1B. Running across each line in these Tables it will be observed that there is a slight tendency for average time per cow to increase as average production increases. The increase is not regular and, because of the relatively small number of herds in some groups and the great variation in milking time existing between herds within the one production group, is not statistically significant.

This is a further indication that milking time could be speeded up especially in herds producing at a low level. In all herds, production of the individual cow should be taken into account and the teat cups removed as soon as milk flow has ceased.

Comparison of Milking Time in Various Ratio Groups.

There is a definite trend throughout in average time per cow, dependent upon the number of units per operator except in those sheds which have $1\frac{1}{2}$ units per operator (i.e. 3 units and 2 operators). In these sheds with an odd number of units, milking takes longer than appears warranted from the units per operator ratio. No explanation for this is apparent but perhaps it is psychological along the lines that, with an odd number of units, the changing of the cups is not the work of one particular operator and each leaves it to the other.

Considering only sheds in which each operator has a definite number of units the trend is quite apparent, one operator per unit getting quickest results (7.05 minutes per cow in case of machine stripping, 6.96 minutes per cow in case of hand-stripping) and four units per operator giving slowest milking (9.88 minutes and 9.57 minutes respectively).

Efficiency of Operation.

Some measure of efficiency of usage of labour can be obtained by studying the time taken to milk the same number of cows under each of the systems. Table 2 is drawn up on the basis of time taken by one operator to milk ten cows using the figures from Tables 1A and 1B.

Table 2.

Time Taken to Milk 10 Cows (Mins.).

No. of Units:	No. of Operators	1	1½	2	3	4
Machine Stripping		70.5	53.7	37.9	28.6	24.7
Hand-Stripping		69.6	54.4	39.9	30.2	23.9

From Table 2 it will be seen that, with only one operator, using 4 units results in the herd being milked rather quicker than using one or two units. Although this is so it also results in each cow being in the bail for a longer period—e.g. in Table 1A with machine stripping and an operator looking after 4 units each cow is in the bail for an average of 9.88 minutes; with an operator looking after 1 unit each cow is in the bail for 7.05 minutes, and with an operator looking after 2 units each cow is in the bail for 7.58 minutes on the average. Thus it does not follow that the saving in labour by the one operator attending to 3 or 4 units is profitable since it involves each cow having the cups on for a longer time. The aim of machine milking should be to get each cow milked out as rapidly and cleanly as possible. If this is not followed there is a possibility that the udder tissues will be damaged causing lowered production or udder infection. These are both very real dangers if teat cups are left on the udder after milk has ceased to flow.

Summary.

A study was made to determine the influence of various factors on the rate of milking by machine on dairy farms in W.A.

Average time per cow was not affected by type of stripping practised nor by average production of the herd.

The number of units under the control of the one operator markedly affected the average time per cow. Findings agree with the conclusion reached by Dr. Petersen that an operator should not control more than two units, if milking is to be carried out efficiently and in a manner not likely to lead to udder injury.

AERIAL BAITING FOR THE CONTROL OF THE LITTLE PLAGUE GRASSHOPPER (*Austroicetes cruciata* Sauss.).

H. E. 111
By C. F. JENKINS, M.A., Government Entomologist.

SUMMARY.

1. An Anson aeroplane with a pay load of 1,250 lb. was successfully used to distribute bran bait for the control of grasshoppers over various types of terrain.
2. Some areas were strip baited, others were given a complete cover. Based on a total cover the area treated was 230 acres.
3. The weight of bran used was four tons or approximately 35 lb. per acre.
4. The actual flying time involved was $3\frac{1}{4}$ hours.
5. The area treated each load was approximately 32 acres.
6. The total cost of the operation was 13s. 6d. per acre, itemised as follows:—
 - Aerial distribution (plus trip to and from Guildford)—6s. 9d. per acre.
 - Aerial distribution (minus trip to and from Guildford)—4s. 3d. per acre.
 - Bait—5s. 2d. per acre.
 - Labour—1s. 7d. per acre.
7. Aerial baiting costs do not compare favourably with distribution by superphosphate spreader and truck over suitable terrain.

INTRODUCTION.

Aeroplanes have been tested for grasshopper control in many parts of the world during the last decade but the insecticides used have been in either dust or spray form.

The aerial distribution of bran bait is quite a recent development in overseas countries and was tried for the first time in Western Australia during the spring of 1949.

The work was done by officers of the Entomological Branch of the Department of Agriculture in co-operation with Airlines (W.A.) Ltd., and with the assistance of the Mingenew Road Board and local landholders.

TYPE OF AIRCRAFT USED AND METHOD OF APPLICATION.

The aircraft used in the baiting operations was an Anson with an estimated pay load of 1,250 lb. The bait was fed through a hopper, designed by Airlines (W.A.) Ltd., fitted in the body of the plane. From the hopper the bait was fed into a chute opening through the floor of the aircraft, the flow of the bran being controlled by a shutter. Clogging was prevented by a manually operated

system of blades very like the revolving blades of a lawn mower which were fitted into the base of the hopper. Test runs were made at altitudes varying from 100 ft. to 150 ft. and at the latter height an effective spread was obtained of approximately one chain, although under certain conditions a spread of up to 30 ft. was covered. The baiting runs were made up and down the target area and across the line of wind, light breezes only being experienced during most of the operations.

Strip baiting was adopted in certain areas and a complete cover treatment was also applied.

A man carrying a white marker flag was placed at each end of the target area to mark the direction of each run and wireless communication was maintained between the aircraft and the ground throughout the operations.

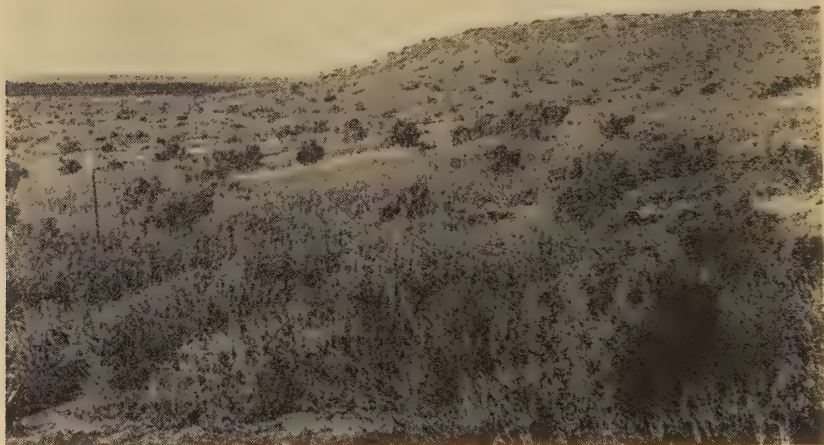


Wireless communication with the aircraft was maintained throughout the operation.

CHOICE OF AREA.

The areas were specially chosen, firstly on account of the uniform distribution and high population of grasshoppers and secondly to test out the ability of the aeroplane to lay bait on different types of country. In two areas low bare hills were present at the one end of the run and an extensive wheat crop at the other end.

A third area consisted of broad river flats bounded by steep sided "break-away" hills and timber. A fourth area was chosen where no topographical features were present to interfere with the flight of the plane.



General view of principal area baited.

AREA COVERED, QUANTITY OF BAIT USED AND TIME TAKEN FOR THE OPERATION.

In all 230 acres were completely covered and four tons of dry bran were used to treat this area. The bait was therefore distributed at the rate of approximately 35 lb. of dry bran to the acre, the actual Departmental recommendation being 25 lb. to the acre. Estimating the pay load of the machine at 1,250 lb. and assuming 50 lb. of wet bran per acre, the plane should have covered 25 acres per run. In actual practice approximately 32 acres to the load were covered due to the low water content of the bran mixture. The actual flying time involved in treating the entire area was $3\frac{1}{4}$ hours and the plane carried seven loads for the complete operation.

RESULTS.

The distribution from the aircraft compared quite favourably with that obtained by other means of distribution, although bait reached the ground in a somewhat more lumpy condition than when distributed through superphosphate broadcasters. The lumpiness of the bait and also the rather heavy dressing

of bran to the acre when computed on a dry weight was no doubt associated with the necessity for having large quantities of bait mixed the day prior to the baiting flights. Some loss of weight would occur due to evaporation and the stacking of the bags also tended to cause lumps. Generally speaking, the actual distribution from the air was satisfactory and the practicability of the method depends mainly upon the cost of the operation.

Large numbers of dead grasshoppers were observed on the treated area the day following the baiting, although optimum results cannot be expected in this particular instance. The morning of the day chosen was bright and sunny but scattered rain storms occurred later and, although these did not actually nullify the operations, they depressed the feeding activities of the grasshoppers for the time being. The best results are usually obtained from freshly laid bait and so the adverse weather conditions on this occasion were particularly unfortunate.

COSTS.

The cost of the operation can be detailed as follows:—

	£	s.	d.
Journey of the aircraft (Guildford to Mingenew and return)	29	0	0
3¼ hrs. actual flying time during bait laying @ £15 per hr.	48	15	0
Total for hire of aeroplane	£77	15	0

In addition to these costs further labour charges were incurred by the Mingenew Poad Board and, although exact figures are not available, they have been estimated as follows:—

	£	s.	d.
Two men loading bran on to aeroplane and tending smoke fire on landing paddock for 1½ days @ £1 6s. 7d. per day	3	19	9
Two markers for 1½ days @ £1 6s. 7d. per day	3	19	9
One truck driver for 1½ days @ 30s. per day	2	5	0
Three men mixing bait for two days @ £1 6s. 7d. per day	7	19	6
Total for labour	£18	4	0

	£	s.	d.
Bran—4 tons @ £10 15s. per ton	43	0	0
Benzene-hexachloride—320 lb. @ 1s. lb. approx. ..	16	0	0
Total	£59	0	0

The approximate total cost per acre of the operation was 13s. 6d., made up as follows:—

	Per acre.
	s. d.
Aerial distribution cost (plus trip to and from Perth)	.. 6 9
Aerial distribution minus cost of trip to and from Perth	.. 4 3
Bait	.. 5 2
Labour	.. 1 7



Deeply eroded flats chosen as one experimental site.

The Director of Airlines (W.A.) Ltd. is confident that these costs can be still further reduced and that from experience gained in the present operations the general technique of aerial baiting can be further improved. The gross cost of 13s. 6d. per acre for the baiting includes cost of bait, wages for mixing, cartage, etc. These costs would be incurred in any form of distribution but the two men acting as markers are an additional charge to the actual flying of the plane.

The total plane hire in this operation was 6s. 9d. per acre inclusive of travelling between Perth and Mingenew. The actual cost of the plane for $3\frac{1}{4}$ hours' flying time was approximately 4s 3d. per acre. It is obvious that where large scale operations were involved the plane hire would not approach this figure, as the amount for travelling to and from the area would be but a small percentage of the total cost.

Although detailed costs for bran baiting with truck and superphosphate broadcaster are not available certain road boards have carried out this work on private property for a charge of 1s. per acre. This figure when compared with 6s. 9d. per acre or 4s. 3d. per acre for aircraft operation gives a liberal balance in favour of the admittedly slower but quite efficient ground method of bait distribution.

CONCLUSIONS.

The aerial distribution of grasshopper bait may have application where it is necessary to treat inaccessible breeding grounds such as deeply eroded paddocks exemplified in some of the areas used in the present experiment, but further improvement will be necessary to get maximum results where narrow strips such as crop edges and road sides require treatment. Six runs were necessary before the fence line bordering the crop in one area was effectively baited.



Loading poisoned bran into aircraft.

Although the experiment clearly indicated that bran bait can be effectively distributed from the air, it also showed that some of the extravagant claims made in favour of aeroplanes for grasshopper destruction were ill-founded.

Where grasshopper distribution is scattered as is often the case, ground reconnaissance would be necessary and ground markers to guide the plane would be required. Baiting long strips of country would eliminate the loss of time in turning but the maximum run under the present conditions would only be four miles due to the limited carrying capacity of the aeroplane. There is no evidence that long narrow relatively isolated strips of bait are effective in controlling the grasshoppers and so any aerial operation would finally involve the treating of large blocks of country. The Mingenew area with its extensive holdings of grazing country has always offered a somewhat unique and very difficult problem as regards grasshopper control. The extent to which much of the rough inaccessible country menaces the cropped areas is still doubtful. Inspections this year showed that while bare, rough hills were some times involved as breeding grounds, by no means all the rough country was included. Furthermore, as many grasshoppers are bred on the arable land, these are the first to enter the crops and the extent to which invasions from distant sources occur is to some extent conjectural.

To treat these areas on a large scale as is now advocated by various organisations and individuals would mean the expenditure of large sums of money as well as the use of thousands of tons of bran, and in the light of present knowledge, the practicability of such a procedure is very doubtful.



Interior view of aircraft showing bait hopper.

When considering the economic aspect of grasshopper control the habits of the insect in question and the value of the crops attacked must be borne in mind. The Little Plague Grasshopper is not a truly migratory species like locusts, and consequently, its sphere of injury is relatively limited. This is not clearly appreciated by those who point to the large expenditure incurred by some overseas countries in locust control. Where fertile high rainfall districts under intense culture are threatened by locust swarms breeding hundreds of miles distant, the control measures which may be justified are very different to those which would be reasonable in many of the affected areas in Western Australia.

Certain new insecticides such as Chlordan and Toxaphene have shown considerable promise at relatively low concentrations in recent oversea experiments, and it is probable that the distribution of these from aircraft as spray mixtures, may warrant more attention than efforts to improve the aerial baiting techniques.

SWINE PARATYPHOID.

(*Salmonellosis necrotic enteritis.*)

C. R. TOOP, Acting Chief Veterinary Officer.

PARATYPHOID is an infectious disease of pigs which is likely to make its appearance wherever pig raising is practised.

It may occur in an acute septicaemic form which is often rapidly fatal and accompanied by serious mortality and in a sub-acute or chronic form known as necrotic enteritis which is characterised by unthriftiness and scouring. The outbreaks occurring in Western Australia are principally of the acute type and they are usually associated with the introduction of pigs from saleyards.

The disease results from infection with micro-organism *Salmonella cholerae suis*. These organisms are passed out in large numbers in the excretions of affected pigs. Consequently the infection may be readily spread by contact between diseased and healthy animals.

Salmonella organisms are frequently harboured by healthy pigs and although such animals are carriers of infection they do not usually suffer any ill effects unless their vitality has been lowered by exposure to unfavourable conditions when they may develop symptoms of the disease. Factors which lower resistance to infection such as exposure during transport and retention in saleyards, bad sanitation and housing and inadequate feeding consequently predispose to the disease.

Measures for the prevention and control of paratyphoid should include the isolation of all newly purchased pigs for a period of three weeks before allowing them to come into contact with other pigs on the property together with attention to sanitation feeding and housing. The last mentioned precautions will require particular attention should an outbreak of the disease occur and in addition the still healthy pigs should be immediately separated from those that are sick and removed to clean quarters.

Badly affected pigs should be destroyed and burned and any that have recovered or have been in contact with affected pigs should be held in isolation until they are ready for slaughter.

Cause.

The majority of outbreaks of swine paratyphoid result from infection with the micro-organism *Salmonella cholerae suis* but other members of the *Salmonella* group of organisms may occasionally also be responsible. These organisms are frequently harboured by healthy pigs being present in the mesenteric lymph glands and intestinal contents. Such animals are carriers of the disease and although apparently healthy they constitute a reservoir of infection. They usually suffer no ill effects but should their resistance be lowered by exposure to unfavourable conditions such as bad sanitation, poor housing and inadequate feeding or as the result of exposure during transit or in saleyards they are likely to become affected, by the disease. It is for this reason that outbreaks of paratyphoid are a common sequel to the purchase of pigs from markets and that losses from the disease are greatest on badly managed piggeries. Mortalities do however, at times occur on piggeries where the conditions of management leave little to be desired.

The disease is disseminated by affected pigs which pass out the infective organisms in the droppings in large numbers thus spreading the infection to the healthy animals with which they come in contact.

The pig itself provides the principal source of infection and there is no evidence to show that *salmonella* organisms are able to survive in the soil or in the environs of the piggery for any great length of time.

American work has shown that a deficiency of the vitamin nicotinic acid in the diet may predispose to the development of necrotic enteritis. This factor does not however, appear to be of any significance under the conditions which obtain in this State.

Symptoms.

Pigs of all ages are susceptible to the disease but animals under six months are most commonly affected.

In the acute form of the disease the affected pigs are dull and dejected, lie huddled together and are reluctant to move when disturbed. When driven they show evidence of general weakness and a staggering gait often accompanied by swaying of the hind quarters. The appetite is lost and there is a correspondingly rapid loss of condition. The temperature is elevated sometimes reaching 107 deg. and the respiratory rate is increased. The skin of the abdomen, brisket, forearms, thighs and ears frequently show a reddish discolouration or rash. When the lungs become affected by pneumonia a cough may be heard and the breathing is rapid and laboured. Diarrhoea which may make its appearance after two to three days is a common symptom, the excretions being yellowish in colour and watery. Occasionally there is involvement of the joints accompanied by lameness.

Death may occur from 24 hours to 2-3 weeks from the onset of symptoms. Pigs which survive often remain poor and unthrifty and show evidence of scouring. This chronic form of the disease is usually referred to as necrotic enteritis. It is not frequently encountered in Western Australia.

Post Mortem Appearances.

The changes observed at post mortem vary according to the duration of the disease and the structures involved. In acute cases the only changes that may be detected may consist of congestion of the spleen, liver, kidneys and lymphatic glands and these are likely to be overlooked by the untrained observer. The spleen may show some enlargement and the lymphatic glands may become swollen and haemorrhagic appearing considerably reddened when incised. Small haemorrhages appearing as dark red spots may occasionally be observed on the surface of the kidney and are more readily visible when the capsule is stripped off. When pneumonia occurs as a complication of the disease the affected portions of the lungs are dark red in colour and solid in consistency and contain many small scattered abscesses filled with greyish yellow pus.

Sub-acute and chronic cases usually show evidence of necrotic enteritis. The affected portions of the bowel are thickened and congested and the lining membrane is ulcerated and contains greyish yellow patches of dead or necrotic tissue. These necrotic areas are usually observed in the caecum (blindgut) and colon (crown) but they may also be present in the lower portion of the small intestine. They may occur in the form of small scattered circular patches but are often very extensive involving several feet of affected bowel.

These dead or necrotic portions of the lining membrane may easily be scraped away with the knife exposing the underlying tissues.

Diagnosis.

In acute outbreaks of swine paratyphoid it is not usually possible to arrive at a definite diagnosis from a consideration of the symptoms and post mortem findings alone. Similar symptoms may be produced by other acute infections and the changes which occur in the tissues and organs cannot be differentiated from those resulting from other septicaemic conditions. Frequently a tentative diagnosis only is possible and this must be confirmed by a bacteriological examination having for its object the isolation and identification of the casual organism.

In such cases a freshly dead pig or better still an animal showing advanced symptoms of the disease should be forwarded to the Animal Health and Nutrition Laboratory for examination; otherwise freshly collected specimens of spleen, liver, kidney or mesenteric lymph gland should be submitted.

Where there are well defined lesions of necrotic enteritis in the caecum, colon or small intestine, diagnosis should present no serious difficulty.

Prevention and Control.

Since outbreaks of paratyphoid are frequently associated with the introduction of pigs from saleyards the precaution should always be taken of isolating newly purchased animals for a period of three weeks before allowing them to come into contact with other pigs on the property. Quarantine pens should be provided from which the recently introduced pigs should not be released unless they have remained healthy during the whole of this period of isolation. In addition yards and sties must be maintained in a clean sanitary condition and in order to increase the resistance of the animals to infection proper attention must be given to housing and feeding.

The piggery should be erected on a dry well-drained site and squalid muddy yards should be avoided. Whenever possible, pigs should be allowed free range in small paddocks where grazing is available. Houses and shelters need not be elaborate but they should be warm and free of draughts but at the same time well ventilated. Floors should be above ground level to avoid dampness and they should be well bedded with clean dry straw. Concrete floors should be provided with wooden sleeping platforms.

The ration fed should be adequate both in quality and quantity and it should contain a sufficiency of protein, minerals and vitamins. Where the ration consists principally of grain, protein should be supplied by the addition of meat-meal or milk and ground limestone at the rate of one per cent. should be used as a mineral supplement. Green feed will usually take care of the vitamin requirements but when it is scarce or unavailable the use of a vitamin A rich supplement in the form of one of the shark liver oil preparations now on the market is advisable.

When an outbreak of the disease occurs in a piggery, the healthy pigs should at once be isolated from those that are ailing. They should be removed to clean yards but care should be exercised to ensure that the new quarters do not become contaminated by the drainage from pens occupied by affected animals. Well constructed feed and water troughs should be provided and feeding from the floor or ground should be avoided. A pure and wholesome supply of water should be available. Attention should be given to housing, feeding and sanitation along the lines already described.

Badly affected pigs should be destroyed and those which have recovered or have been in contact with affected pigs should be kept separate from other pigs on the property until they are ready for slaughter.

The treatment of affected pigs is generally regarded as unsatisfactory. More recently promising results have been reported from the administration of some of the sulphonamides, but further information will be required before a definite recommendation can be made. Recoveries have been reported following the sub-cutaneous injection of Sulphamethazine Sodium Solution 33½ per cent., at the rate of 15cc. per cwt. body weight and repeated daily when necessary for five days.

THE SALT PROBLEM IN THE WHEAT BELT.

By G. H. BURVILL, Commissioner of Soil Conservation.

Two broadcasts on the salt problem were given on 29th March and 22nd April, 1949, and are reproduced by permission of the Australian Broadcasting Commission.

IN the wheat belt of Western Australia bare patches in farm paddocks are often seen. Many are bare, or almost bare, because of too much salt in the soil. The excess of salt prevents the germination of seeds, or kills living plants, because it causes the water supply for germination or growth to be cut off. This salt problem is so serious in places that single farms or groups of farms have been ruined; wheat growing on them has become unprofitable. Salt patches are common on farms all over the wheat belt, but their total area is still only a small part of the land so far brought under cultivation. Still, salt is, undoubtedly, a widespread wheat belt problem and there is, quite rightly, a lively interest in it, and particularly in its practical solution.

Let us first get the problem in proper perspective. This will help to guide our understanding of it and our reasoning to combat it.

The wheat belt, using the term in a broad way, lies generally between the twenty-five inch and the twelve inch rainfall lines. Geraldton, Moora, New Norcia, Toodyay, Williams, Kojonup and Cranbrook roughly mark the western side and Ajana, Mullewa, Kulja, Mukinbudin, Walgoolan and Lake King lie at the drier margins. It extends over about thirty-five million acres if we exclude the Ravenshorpe and Salmon Gums districts. Only about one-third of this, or twelve to fourteen million acres, has yet been cleared and put under crop or pasture. Scrub plains, various types of light lands, and mallee areas, make up an area greater than the present cleared land.



There are various types of salt affected land. Here is an area on a slope adjoining a gully where a seepage developed after clearing and evaporation caused a sterile salt patch now eroding. Such patches are common in the wetter wheatbelt lands.

Photo. (W.A. Govt. Printer).

What area of land in the wheat is salt affected? How much more may become affected? These questions can't be answered accurately, but they are important and worrying to individual farmers, and to bankers and administrators. Fairly often a fear is expressed that the whole wheat belt will be ruined by salt. I don't believe there is the slightest chance of this. But many single farms, or paddocks or smaller areas have become almost useless and the individual owners have a right to be worried about the future.

In 1925 inquiries about salt were made on a number of farms in the older and wetter parts of the wheat belt. Only 3 per cent. of the area of the farms was salt affected. It might be double that now in these fifteen to twenty-five inch rainfall areas. If so, still only a twentieth or so of the land is affected. Some old farms even report an improvement in their salt lands, and soaks and wells which turned salt have also become much fresher in some places.



The level of the salt ground water has risen on broad flats and caused bare salt areas to develop. The native vegetation has been killed as shown and excavated dams have become salt.

(Photo G. H. Burvill.)

In the drier parts of the wheat belt salt was widely investigated by Dr. Teakle ten to twenty years ago. Certain soils, such as the snuffy morrel types and heavy crabholey soils, and some heavy soils near the salt lakes, were generally high in salt and caused much trouble when used for wheat. Many farms were abandoned, partly due to this cause. But it must not be overlooked that large areas in all these districts are not salt affected, and that these outer wheat belt areas have proved to be very good stock districts, especially for sheep. In fact, the whole wheat belt is really a wheat and sheep belt.

The salt problem is not by any means a new one. Before 1900 railway water supplies in the Great Southern became salt affected. The trouble was traced to the clearing of catchment areas. In the Northam-Toodyay country about 1897 it was suggested that clearing the native vegetation turned the water in the creeks salt. By 1904 salt was a problem at Goomalling, and salt areas along creeks and gullies became quite common as the fifteen to twenty-five inch rainfall belt was developed.

The lower rainfall areas opened up just before and after the 1914-18 war seemed to be free of this type of salt trouble. In some places, as I said a while ago, certain soil types, whether at high or low levels, developed bare salt patches a few years after clearing. But now, in country cleared twenty to thirty years, salt is also causing trouble on flats along the drainage lines, because the level of the salt ground water has risen. Instead of being twenty to thirty feet, it is now three to six feet from the surface. In some cases the trouble has become rapidly worse a year or two after very wet winters. The winters of 1945 and 1946 will be remembered for the large amounts of water which flowed along all drainage lines to the salt lake systems in the wheat belt. From the lakes much water even found its way to the sea via rivers such as the Blackwood, Avon and Swan, and the Moore River.



Bare salt patches develop in some outer wheatbelt soils with 11 to 15 inch rainfall. Grey powdery morrel country and heavy soils near salt lakes are often affected.

(Photo. G. H. Burvill.)

Why have the water levels risen in the flats? And where does all the salt come from?

The salt has come from the sea but in two different ways. Firstly, a lot of the southern half of the State was under the sea for a time about fifteen or twenty million years ago. Since it was lifted up again all of the salt has not been washed out and taken back to the ocean. Secondly, salt comes down with the rain water. At Merredin, sixteen pounds of salt comes down in the rain water and dust on each acre every year. In many years there is very little run off, and so for thousands of years this salt has been building up in the soil. So before farming started in the wheat belt there was a lot of salt in the soils and subsoils especially of the heavier types and in the low lying parts.

Now, salt movement in the soil depends on water movement, and salt in the subsoil might cause little trouble if it would stay there. But it has come to the surface and caused sterile patches in many places. This is because to farm the country the natural vegetation had to be removed. The native vegetation has been a very important factor in controlling soil water movements. Removing the timber and scrub from twelve to fourteen million acres has caused big changes,

some good, some bad. Soaks and springs which develop after clearing provide stock water in many places. But rising salt water levels on flats, and upward capillary movements of moisture from salty subsoils, have given us the salt problem.



Wind erosion on salt affected land which has been grazed for several years with no cultivation or seeding.



Even a few plough furrows on salt affected areas can provide a place for blowing seeds and soil to lodge and for water to collect after rain and so help to produce some plant cover.

(Photos. G. H. Burvill.)

Less clearing in some flats may have delayed the trouble but not prevented it. The salt problem in our wheat belt is an inevitable consequence of farming the area. We must accept it as a problem and look for ways of reducing its severity. In a later talk I will discuss methods which may be used on various types of salty land.

A few weeks ago I told you something of the history and causes of the salt problem in the wheat belt. Today I want to deal with possible ways of treating salty land.

In my previous talk I said that the salt mainly moves to the surface with soil moisture. Since the native vegetation has been removed from twelve or fourteen million acres much rainfall which used to be absorbed by the roots of trees and scrub now finds its way deeper into the soil or to low-lying parts. Some returns later to the surface and brings salt with it. We had to clear the land to farm it; a salt problem in parts is one of the consequences. Altered soil moisture conditions have caused salt movements. Our problem is then to obtain better control of the soil moisture.

What steps can we take to handle salt affected areas, or areas which may become affected?

There are three different types of salt affected land which we must recognise before we can decide what might be done with each. Firstly, there are places where springs and seepages develop along the sides of gullies or higher up the slopes. Here a tight subsoil layer brings moving underground water close to the surface where it evaporates leaving a salt crust. These places are quite wet, even in summer. Secondly, on fairly extensive flats, salt water is now found about three to six feet from the surface, and bare salt patches are very common. They remain damp in summer, but often have a loose puffy surface. The third type is mostly confined to the lower rainfall country. Bare salt patches, sometimes caked, sometimes powdery, are found at high or low level on some of the heavier types of soil. There is no shallow watertable in such cases. The soils have always been quite salty and concentration in the surface in excessive amounts has taken place by upward movements of soil moisture.

Bearing in mind the need to control soil moisture I want to stress the importance of growing plants for this purpose. We know how weeds rob moisture from a fallow where we want to store it. We need more plants on salty or salt liable areas to use up moisture which may otherwise come to the surface and bring up salt. For the first type of salt land I mentioned with ample summer moisture, a creeping grass *Paspalum vaginatum* is showing great promise. It comes from the west coast of South Africa where it is periodically covered by ocean tides. So far it can only be planted from roots and cuttings. These have been sent to a number of farmers from Avondale Research Station, Beverley. Salt couch or river couch *Sporobolus virginicus* may also be useful in such places.

The other two types of salt land are generally much drier in summer even on the bare patches. Farmers are often afraid to continue cultivation and cropping in case this makes them worse. I know of no evidence to support that idea. In fact I think every effort should be made to encourage more growth on such lands by cultivation, seed and fertiliser. But they should not be fallowed while there are living plants on them, and they may not grow good grain crops. Early maturing cereals such as Bungulla wheat, Wongan oats and perhaps Greenough barley, along with Wimmera rye grass and super, could greatly improve the plant cover and the grazing on many such areas. With wool and cereals at present prices there is a good chance to break up and plant some salty land which may have been untouched for years.

Are there any more salt tolerant plants you will ask? Yes, there are, but they have difficulties for large scale planting. Saltbushes are salt tolerant but are soon eaten out, unless very lightly grazed. Trailing saltbush has been tried by many farmers. A few have tried old man saltbush grown from cuttings. It may



PLANTS FOR SALTY LAND.

Top.—*Paspalum vaginatum* a salt tolerant summer growing grass for salt seepage areas which stay moist in summer.

Middle.—Trailing saltbush (*Atriplex semibaccata*) on salt land.

Bottom.—Wimmera rye grass (*Lolium rigidum*) suitable for use with cereals on land with scattered salt patches.

(Photos G. H. Burvill and L. J. H. Teakle.)

grow too tall for sheep to eat out, if carefully handled for some years. Beetroot, silver beet and mangles are all very salt tolerant and belong to the same plant family as the saltbushes. Curly rye grass (*Pholiuris incurvis*) with its curved and shiny leaves is often found at the edges of salt patches. Small amounts of the seed heads might be spread by hand but clean seed would be impossible to get. Cultivation and super would encourage it where it is spreading naturally. Wimmera rye grass is fairly salt tolerant, and can of course be planted with ordinary drills and combines.

Where flats have turned salt through a rise in salt water level the possibilities of drainage or tree planting are often raised. If there is excess water in the soil it is natural to think of drainage. But in practice drains often require close spacing to be effective. Large main drains can remove extra surface water more quickly but in clay subsoils will not give effective drainage over wide areas. In the irrigated vine areas on mallee soils at Mildura effective drainage has cost about forty pounds an acre. Drainage does not appear to be a practical solution in the flat wheat belt valleys.

Tree planting could only be really effective in helping salt control if carried out over large areas, which could not then be used, even for grazing. Planting trees for shade, shelter and fuel, is of course, always worth considering.

And finally a word about subsoiling which has been suggested as a means of handling salt land. There is no evidence I have yet found to show that subsoiling has improved the growth on salt land *as compared with the growth obtained from working to ordinary depths with plough or scarifier.*

WINDBREAKS AND SHELTERBELTS IN RELATION TO SOIL EROSION.

By G. H. BURVILL, Commissioner of Soil Conservation.

*(Broadcast delivered 26th July, 1949, and now reproduced by permission
of the Australian Broadcasting Commission.)*

THE 1948-49 summer was long and dry in most of the south-western part of our State. This was specially so in the wheatbelt where the dry summer and autumn followed on a rather dry season last year. With reduced growth of crops and pastures, the grazing of stock and, in some cases, the effects of grasshoppers, many paddocks were almost bare for some months. On windy days clouds of dust were a common sight. Drifts of soil were often noticed against netting fences and, in some cases, had extended on to roads. The thoughts of many people were thus focussed on the menace of soil erosion by wind, and ways to prevent it were more seriously considered.

Windbreaks and shelterbelts of trees and scrub are thought by many to be the answer to wind erosion troubles, but I want to make it clear that they have definite limitations. What is far more important is the way the farm lands as a whole are treated with respect to cultivation, cropping and grazing.

But let us consider further the effects of windbreaks and shelterbelts. We all know the comfort and shelter to be found for man or animals on a windy day on the lee side of an area of scrub or timber. The speed of the wind within a few feet of the ground is obviously much reduced by the trees and scrub. For this reason alone, belts of trees and scrub have a place on every farm. All too often do we see farmers' homes and buildings with very few trees about them, because no thought was given to the homesite before the land was cleared.



Belts of timber along roads and fences make for a more attractive countryside as seen in this picture of salmon gum country between Gnowangerup and Borden. There is also shade for stock and protection of fences and roads from any soil drift.

(Photo. W.A. Govt. Printer.)

Where uncleared land or wide strips of scrub or timber adjoin roads and fences, drifted soil is rarely found on the road or fences. By contrast, roads and fences with cleared land beside them are, in many parts of the wheatbelt, more or less affected by drifted soil. This is especially so in sandplain areas, and some country road boards are very concerned about it. And so, for the protection of roads and fences, belts of scrub, mallee or timber, are of great value. In many cases a strip one chain wide is probably enough, but wider strips, say, two or three chains, are safer where stock have access to them. The trampling and grazing of stock reduces the natural regeneration of trees and scrub. Along a fence line a cleared strip a few yards wide is always a good thing for fire protection and is usually made when the fence is built.

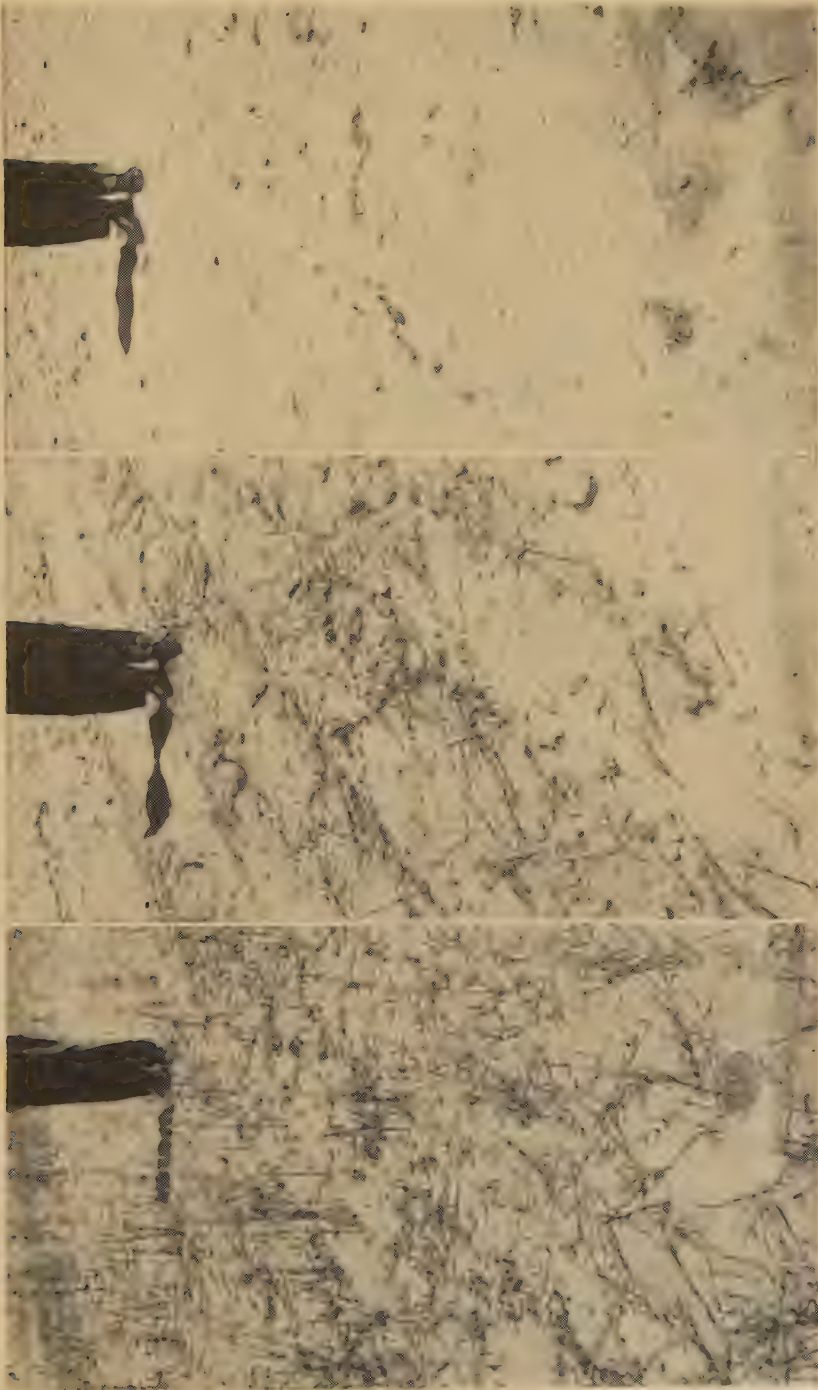
Banks of sand and drifted soil are often found extending ten to twenty yards into scrub or mallee where they adjoin cleared paddocks. The soil has been deposited because the speed of the wind has been reduced and it has been unable to carry the soil particles at its reduced speed. *Reducing the wind speed at ground level on farm paddocks is thus the key to reducing or preventing soil erosion by wind.* Belts of scrub and timber reduce the wind speed at ground level in adjacent areas but their effect does not extend as far as many people imagine. There is little effect beyond a distance ten to twenty times the height of the shelterbelt. Thus *a belt of trees fifty feet high will have little effect on the ground wind beyond about one thousand feet—about fifteen chains.* Scrub six feet high could not be expected to give any real protection for more than about one hundred feet. I have seen clear evidence of wind erosion from fallow in sandy-surfaced mallee country where the cleared area was only ten chains wide and the mallee about twenty feet high. So that, even if every wheatbelt paddock of one hundred to five hundred acres in size had a two-chain belt uncleared around it, the possibilities of wind erosion would not be eliminated. Fences, roads, buildings, homes and stock, in and close to the windbreaks, would benefit, but on the broadacres we must consider other ways of protecting the soil surface. *Stubble, pasture, avoidance of overgrazing, care in fallowing, especially on sandy-surfaced soils, and general farm management must still be our main defences against wind erosion.*



Belts of scrub and mallee along boundaries and fences can provide shelter for stock and protect fences and roads from any drift which occurs. In this picture drift sand from the cleared area to the left has formed mounds extending about half a chain into the natural scrub.

(Photo. G. H. Burvill.)

At present many new areas of light land are being developed in the wheatbelt, and some soil drift on these areas is likely to occur, even under careful management. In the interests of the farm owner and the community generally, it is worthwhile to consider having belts of scrub and mallee or trees along fence lines and adjoining roads. The control of clearing by regulation under the Soil Conservation Act may be necessary to make sure this is done. Sometimes it is more



When sandy surfaced soils are cultivated for crops special methods may be necessary to check wind erosion. These pictures from sandy scrub plain land show—Left—Remains of grasses scattered in oat crop. Middle—Similar grasses oat crop stripped in October to leave ridged trashy surface. Right—Normal fallow, disc ploughed in July, leaving an almost bare surface which shows fast and erodes. (Photos. G. H. Burvill.)

convenient to clear an area and later allow regrowth of scrub along fence lines or in convenient places. Most of our mallee and scrub vegetation makes a rapid regrowth after clearing on areas which are unploughed, or not ploughed more than once. There are likely to be advantages, too, from a dressing of super on windbreak areas.



Wind erosion from yellow sand plain has partly buried two fences and blocked a road at Dowerin. The planting of cereal rye shown here has checked the drift and the road has been made passable again.

(Photo. G. H. Burvill.)

Many farmers know the difficulties of growing trees on completely cleared land. They require to be fenced off from stock and also to be kept reasonably free of weed competition in their early years. So that, in naturally timbered areas, windbreaks and shelterbelts need to be carefully considered before clearing is done. It is too late in many places to do this and replanting is the only alternative. Our Forests Department has always been interested in the supply of trees to farmers and large numbers go out each year from the nursery at Hamel. In recent years another Forests Department nursery at Kalgoorlie has given special attention to trees suitable for the drier areas. A number of our native gum trees from the goldfields and wheatbelt are now available and farmers who are interested should contact the Forests Department in Perth for information on the trees available and their suitability for different types of soil.

But remember again that *proper attention to cultivation and grazing practices* will still be a major factor in controlling wind erosion on our farm lands, even when windbreaks and shelter belts are there to assist.



BEE COMBS—PREPARATION AND MANIPULATION.

(Revised from Leaflet 566 by R. COLEMAN, Government Apiculturist.)

NEXT in importance in the production of honey to the stocking of hives with pure bred bees of a good strain, is the provision of good combs, and the careful and intelligent arrangement of them in the hive. Very often this is overlooked by beekeepers, either owing to lack of knowledge or carelessness.

The invention of the movable frame and wax foundation and the centrifugal extractor during the last century entirely revolutionised beekeeping, and enabled beekeepers to regulate the rearing of brood, reduce swarming, and produce larger crops of honey; and the scientist to study with exactitude the economy of the hive. The days are past when at the end of the season the beekeeper, to obtain the crop of honey, had to either destroy the bees or drum them into another skep or box, cut out the comb, and separate as far as possible the brood comb from the combs of honey, which were crushed and often contained small quantities of eggs, brood, or pollen. The honey was then strained; but all the straining could not rid the honey of the flavour of the brood and pollen.

Present-day methods are absolutely hygienic, as anyone can testify who has witnessed the removal of honey from the hives, and its extraction and preparation for the market.

Frames.—Good combs can be used for many years for brood rearing, or the storage of honey. To obtain these a good pattern of Root Hoffman or other standard self-spacing frame should be used, and the Victorian pattern with square sides is recommended.

There are four sizes of standard frames at present in use in Australia. These are similar to those generally used in America. The dimensions of our frames, however, are different from those generally used in Britain. All four sizes are of the same length, that is 19 inches long, with projecting tags for suspension in the hive, the only difference being in the depth. The standard size is $9\frac{1}{8}$ inches deep, and is generally used by all the large beekeepers for both the brood chamber and the supers or honey chambers. The three-quarter depth or W.S.P. Frame, which is $7\frac{1}{8}$ inches deep, has only come into use recently and is favoured by some beekeepers as it allows more gradual expansion of the hive for brood rearing or storage purposes.

The Bolton or Ideal Frame is $5\frac{3}{8}$ inches deep and was originally introduced for the same purpose as the W.S.P., and for controlling swarming by Bolton's method of reversing the combs. The half depth is $4\frac{1}{8}$ inches deep and is intended for use as a super for honey storage when the flow is not heavy enough for the full depth frame. The advantage of using this frame for storage as against the Ideal or W.S.P. is that the standard extractor will take two frames in the place of one standard full depth; whereas it will only take one Ideal or W.S.P.

Another important recent use for the half depth or Ideal Frame is to place a box of these full of honey on the hive as a food chamber for the winter and spring brood rearing. Colonies with food chambers are ensured against starvation and come out stronger and start brood rearing earlier than those with a scarce supply of honey.

Foundation.—All frames should be strongly wired and fitted with full sheets of foundation. The only exception is where swarms are hived. These may have starters instead of full sheets, as swarms are in a condition for comb building and invariably build worker comb in the first instance. The practice, however, is questionable, as some bees are bad comb builders, and do not always build straight combs, and sometimes, even when foundation is given, bush bees that are used to building comb just as they please in hollow trees, will make a bad job of it.

There are three important reasons why full sheets should be used:—

- (1) Experiments have proved that bees consume from 12 to 16 lb. of honey to make one pound of wax, therefore, for every pound of wax foundation supplied, the bees will store an extra 12 to 16 lb. of honey.
- (2) By giving a straight full depth vertical foundation, the bees will build thereon in the right direction, and fill the frame with a straight good comb, so that any comb can be removed without cutting or breaking, as required by the Bees Act.
- (3) As the foundation is embossed with the bases of worker cells, the bees will build all, or nearly all worker comb. If only starters are given, the bees just before swarming time, and often when there is a honey flow on, will frequently build drone instead of worker comb. Then when the queen lays eggs in these cells, she will lay drone eggs, and hundreds, or even thousands of drones will be hatched instead of workers, and the honey crop will be much reduced.

It will, therefore, be obvious that it pays well to use full sheets of foundation.

Wiring.—There are several methods of wiring. Four of the most general are illustrated herewith.

Frames as purchased usually have four small holes drilled in the end bars ready for the wire. Two small tacks should be driven half home, one near the top hole and one near the bottom hole of one end bar at Nos. 1 and 8. Now take the reel of wire, which should not be of smaller gauge than No. 28 B.W.G.—unless the new nonstretching wire is used—when No. 30 will be quite strong enough. This wire is now obtainable from suppliers of bee requisites.

Thread the wire through the holes and twist the end round the tack; drive the tack home; stretch the wire until it twangs like a musical instrument; then twist the other end of the wire around the other tack, and drive this tack home. Experience will show if the wire is too tight, as then the frame ends bend, and the wire cuts into the wood.

When fitting the foundation, the frame should be placed upside down and the foundation threaded between the wires, so that the wires are on alternate sides of the foundation, which must now be secured to the top bar. If an electrical embedder is used, contact is made at each end of the wire for a few seconds until the wire is warm and sinks into the wax. If a spur wheel embedder is used, this is heated in the flame and run along the wire quickly and evenly and presses the wire into the warm wax.

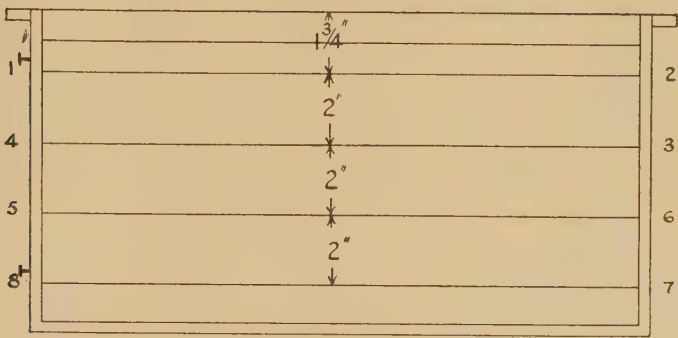


Fig. 1.

Figure 1. This is the only method of the four shown which could be used with the electrical embedding board, wherein the terminal contacts are made with each end of the wire. This method has two faults which tend to outweigh the advantage of its simplicity. These are that the comb tends to sag in hot weather, and thereby stretches the worker cells, allowing the bees to make drone cells, and secondly the comb cannot withstand the centrifugal force as well in the extraction process.

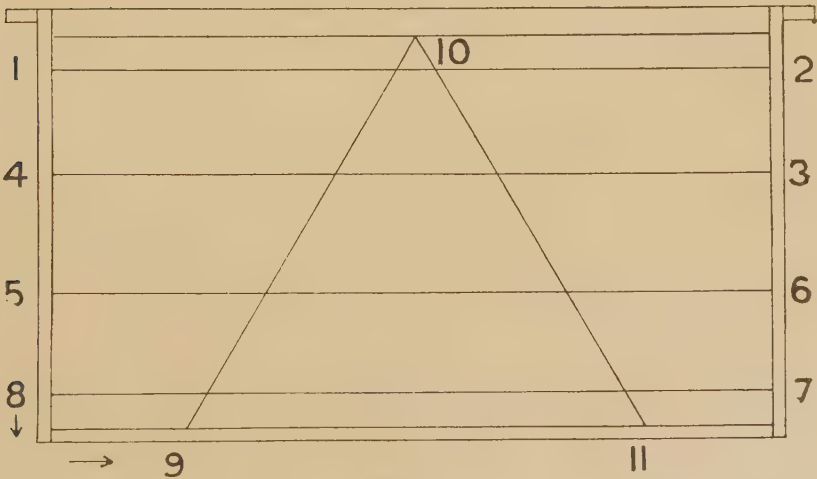


Fig. 2.

Figure 2. This method of wiring is the same as in figure 1, except that there is an extra wire forming an inverted "V" in the centre of the frame, which overcomes the two faults in the first pattern of wiring. This "V" must be threaded through the four parallel wires in the same weave as the foundation, so that the foundation can be inserted between the parallel wires. The "V" is secured either to nails made into hooks, or threaded through holes in the wood, and secured by tacks on either side.

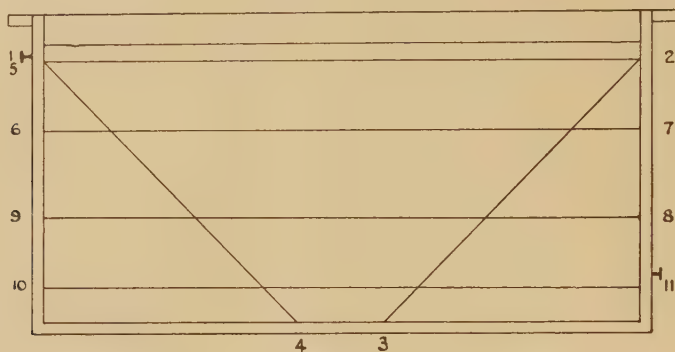


Fig. 3.

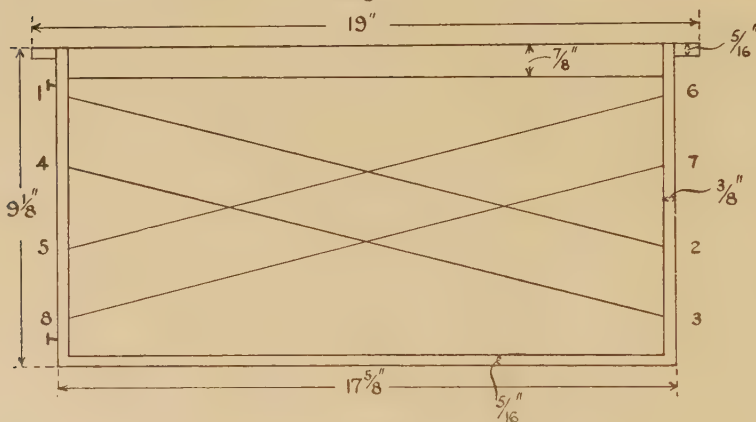


Fig. 4.

The wiring of Figures 3 and 4 is similar, and has the same purpose as that used in Figure 2, but the method of threading varies as shown by the numbers.

Some beekeepers use No. 26 galvanised wire for a very strong comb not liable to break in the extractor, but the bees sometimes object to the thick wire and eat away the wax along its edge.

For Ideal or Bolton frames, or for half depth frames for supers, two cross wires are usually sufficient. For W.S.P. frames, which are used for both brood chambers and supers, three cross wires should be used.

Fitting Foundation.—There are several methods of fixing the foundation to the top bar.

Wedge and Groove Frame.—With the wedge and groove pattern of frame, the foundation is inserted in the middle groove, and the wedge pressed or tapped firmly into the side groove, so as to press the middle strip tight against the foundation. The objection to this method is that the grooves are harbours for wax-moths, which burrow into them for the purpose of pupating, eating away the wood to make their cocoon.

Single Wedge Frame.—With this pattern the wedge is removed from the bar and the foundation inserted; the wedge is then turned upside down, and replaced in the bar, and pressed firmly against the foundation. Four or five thin nails are then driven in, in a slanting direction through the wedge, to hold it tight against the foundation. In this pattern there is not much opportunity for the wax-moth to do damage.

Mounded comb guide is another pattern, very little used, and I do not recommend it.

Single Groove.—This is probably the best type to use. The foundation is inserted into the groove and hot wax run along both sides of the foundation. This fixes it firmly into the bar, and there is then no possibility of the foundation falling away from the bar with the weight of the bees, as often happens with the wedge and groove, and single wedge, unless the beekeeper is careful to make a firm job.

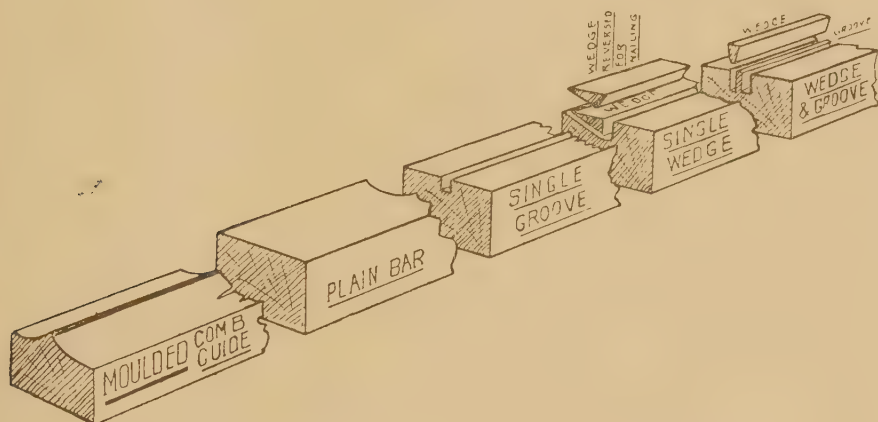


Fig. 5.

For Embedding the Wires.—There are three general methods used:—

First Method.—This method can only be used with the frames wired as in figure 1, where there are no crossing wires. The basic principle is that the two terminals of the leads from the battery touch the ends of the wire in the frame, thereby heating the wire, which melts the wax allowing the wire to fall into the midrib of the foundation. Care must be taken not to make the wire too hot, or the foundation will be cut. In the accompanying diagram will be seen a typical wiring board. It is a board, 22 inches wide and 2 feet in length, on which both wiring and embedding can be done. With the terminal electrical embedding there is a board $\frac{3}{4}$ inch in thickness underneath, which supports the wire and foundation. A similarly sized board is placed on top of the foundation in the frame, and a heavy weight placed on this so that the wire and foundation are kept in close contact by pressure. The current is then switched on for a short time, and the whole four wires are embedded in the one process.

Second Method.—With this method each of the four wires is embedded separately. As in the first method the frame is placed over a board just slightly smaller than the frame, so that the foundation and wires are kept in close contact. After the first and third wires have been embedded, the frame is turned over to do the second and fourth wires.

Third Method.—The wires are embedded separately in a similar way to the second method, except that instead of embedding them electrically a warmed spur-wheel is used to force the wire down into the cold foundation.

Wired Foundation.—The wiring of frames and fitting of foundation is one of the beekeeper's most tedious jobs, and is a comparatively slow process. Much thought and time have been spent by inventors to improve the strength of combs and the saving of time; such as aluminium foundation and other substitutes for wax, but none has been adopted to any extent. Two of the latest are three-ply

foundation and wired foundation, both of which are being used to a large extent in America. The three-ply foundation is made of three very thin sheets of wax, the centre one being of vegetable wax for strength, and the two outer ones of natural beeswax. This is used and fitted in the same way as ordinary foundation.

The wired foundation was first made by Dadant and Sons, U.S.A., and is now also made in a slightly different pattern by Pender Brothers, N.S.W. I have tried the Dadant foundation, which is used in special frames with slotted bottom bars, and find that it does away with the tedious wiring and embedding and saves about 75 per cent. of time. The combs drawn out by the bees are as perfect as one could desire—working cells from top to bottom bar with only an occasional pop hole in the corners.

The Pender wired foundation is similar, but has straight vertical wires instead of crimped, and the fixing to the bottom bar is slightly different, but the resultant combs should be as good as the Dadant, and I would strongly recommend beekeepers to give it a trial.

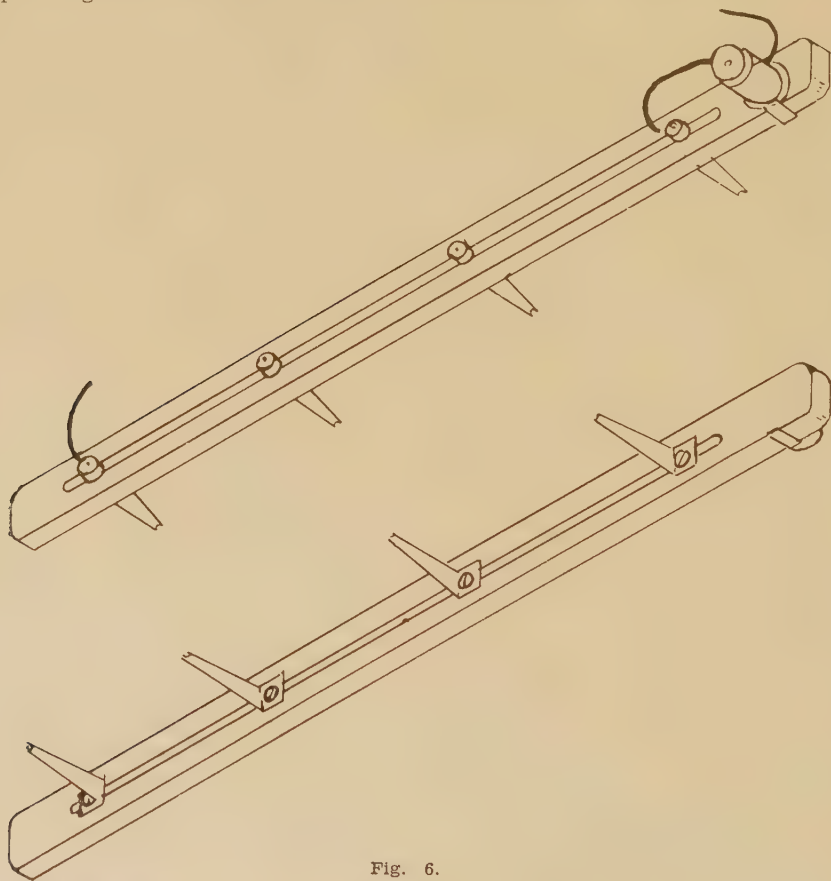


Fig. 6.

The four terminals are notched to fit the wire, and all are movable along the slot in the bar by means of thumb screws.

The outside terminals are the only ones connected with the battery, the other two being used solely for holding the wire down. The horn button allows for easy regulation of the flow of current.

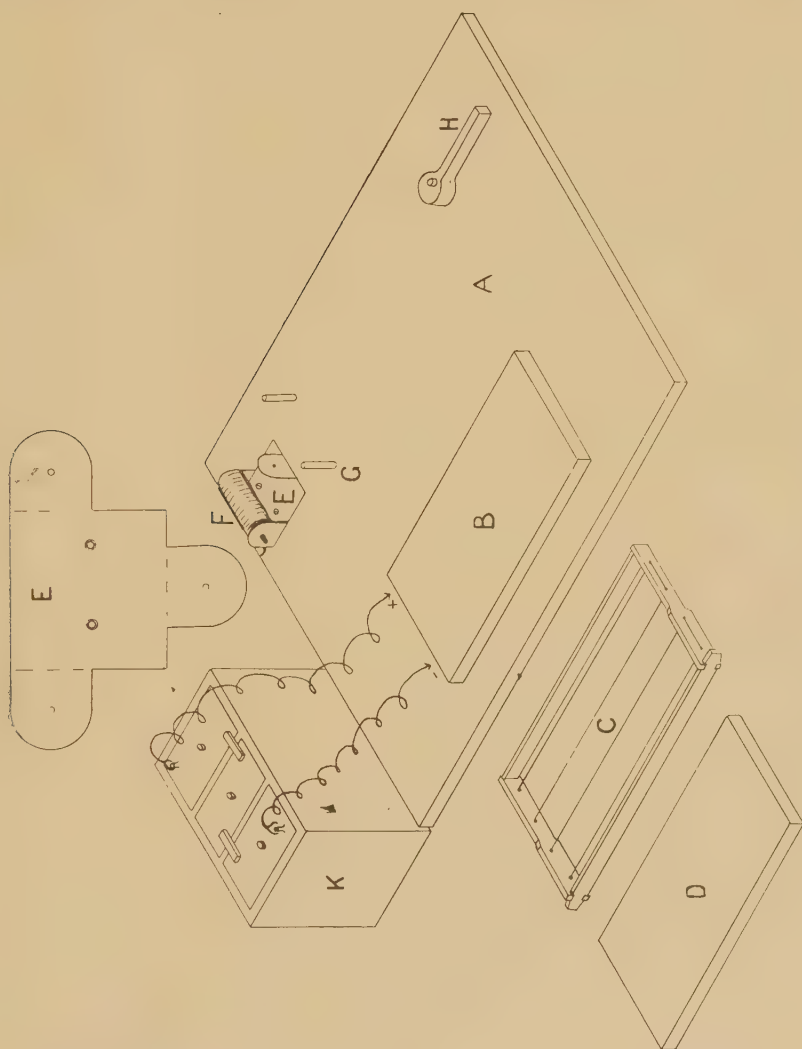


Fig. 7.
Wiring and embedding board.

- (a) Board approximately 22in. x 24in.
- (b) Board $\frac{3}{4}$ in. thick which will just fit inside the type of frame used.
- (c) Typical frame.
- (d) Board identical to (b) which is placed on top of the foundation with weights over it to maintain contact between the wax and the wire.
- (e) Shaped piece of 24 or 26 gauge sheet iron which forms the holder for the spool of wire. The iron is bent upwards where shown by the dotted lines.
- (f) Spool of wire in the holder (e).
- (g) Two dowels, to hold the frame while pressure is being exerted by (h).
- (h) The concentric wheel and lever which bends the end bars of the frame, so that the frame after being wired, when released will tighten the wires.

The fitting of wired foundation into frames is a very easy matter. The frame to be used is the single wedge, or single groove. If obtainable, the square wedge is preferable to the V. type. All that has to be done is to insert the foundation into the frame, place the wedge into position, and nail; or in the case of single groove, run the hot wax into the groove.

Building the Combs.—The next job is to get the frames of foundation drawn out into full combs. They may be given to either swarms or to colonies that are rapidly increasing in numbers, or when there is a prospect of a honey flow. If the swarm is small, or the bees are only increasing slowly, it is best to give only two or three frames of foundation at a time, because if there is only a little honey coming in, the bees often tear down some of the foundation to use on other frames. Also in cool weather an excessive number of frames of foundation reduces the temperature of the hive.

Position of Combs.—Now as to the situation of frames in the hive. It must be remembered that the brood nest is usually in the centre and warmest place of the hive, and that the bees cluster thereon to hatch the brood. The outer circle of these centre combs contains pollen and honey, and the combs next to the brood nest also contain pollen and honey, being easily accessible to the young bees that have to feed on them to make the chyle or milk food for the larvae. Next come combs of honey, and lastly, if there is still room, combs in course of construction.

Increasing the Brood Nest.—The natural place, therefore, for undrawn foundation is on the outside. However, in warm weather, when there is plenty of honey coming in and breeding takes place, single combs may be placed next to the brood nest, as this hastens their drawing out, the bees being anxious to fill them with brood or food. A good time to get the combs drawn out is when the spring is well advanced and the brood chamber full of bees, brood, and honey. It should be the aim of all beekeepers to get two chambers full of brood and honey before trying to secure any surplus honey. To do this, take a body the same size as brood chamber to use as a second storey. Now take two or three frames of brood out of the bottom chamber and place in the centre of the second; close up the remaining brood combs and place frames of foundation on each side between them and the combs of honey, first damaging the cappings of any honey above the brood. The bees will then remove the honey and the queen will deposit eggs therein; otherwise there might be a bar of honey between the two chambers which the queen would not pass. If there is only a little honey in the brood combs placed in the second storey, it would be as well to transfer a comb of honey with them. Now fill up the second chamber with the frames of foundation, and close up. If the season is good, and the queen young and of a good strain, it is surprising how quickly she will fill the two chambers ready for the main honey flow, when a further one or two bodies may be placed on top. No excluder will be needed if the beekeeper manipulates the frames in the two lower chambers correctly, as the queen seldom climbs to the third storey unless overcrowded below.

Manipulation of Combs.—In the manipulation of hives with old combs, the dark worker combs should always be placed in the centre where the brood nest is, and any drone combs on the outside next to the walls of the hive, as this is the last place the queen will lay in, unless of course, drones are required for mating purposes, in which case one or two such combs should be placed in the centre. Drone combs may also be placed in the supers for the storage of honey.

Dark worker combs are also useful to place in the second storey next to the brood, or with a swarm that has been hived; one comb of brood and one dark worker comb for the queen to lay in will often prevent the swarm from absconding.

Renewal of Combs.—The cells of combs that have been used for the rearing of many generations gradually become smaller, as each chrysalis leaves a thin skin behind it. When the cells are noticeably small, the combs should be replaced, otherwise the young bees will not be able to develop to their natural size.

Badly damaged combs, or those with an excessive amount of drone cells, or those which have sagged and been patched up by the bees, so that there are a number of irregular cells that cannot be used for brood rearing, should never be placed in the brood nest, but should be taken away and melted down—otherwise there will be so much waste space where every inch is valuable, brood rearing of the workers will be restricted, and the tendency to swarm will be increased.

Stretched cells on the upper portion of the combs in the lower brood chamber have a tendency to act as a bar to the queen passing from one chamber to the other—should there be any of these, they should be placed in the second chamber. Careful sorting and arrangement of all combs is of great assistance to the bee-keeper in the prevention of swarming and the storage of surplus honey.

RECENT DEVELOPMENTS IN CHEMICAL WEED CONTROL.

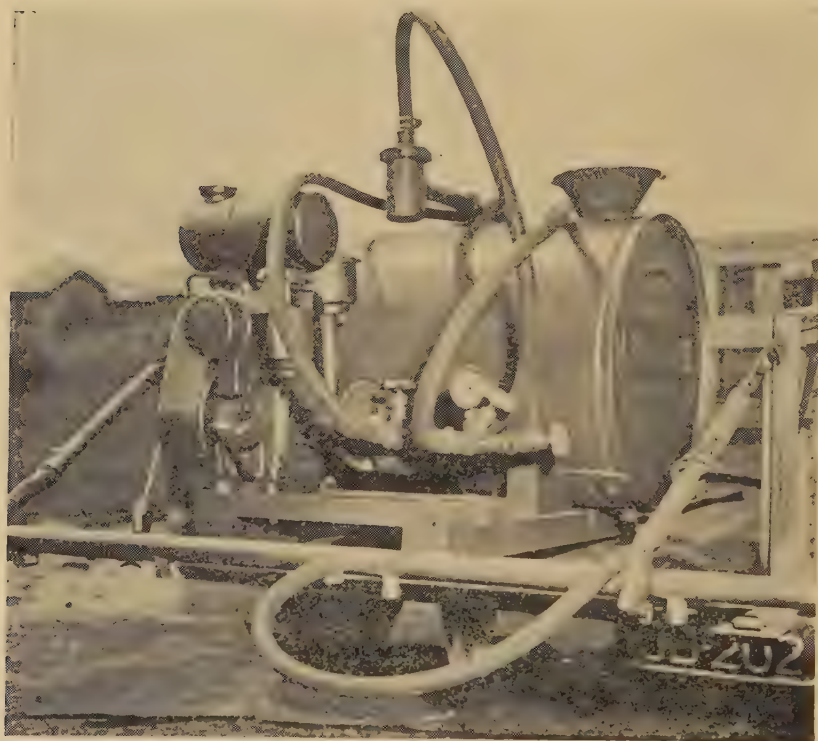
Broadcast by G. R. W. MEADLY, Weed Control Officer.

Reproduced by permission of the Australian Broadcasting Commission.

IN recent years one of the most spectacular advances in agriculture has been made in the realms of selective weed control, and the chemicals which have played the most prominent part are hormone-like preparations. Fortunately a series of abbreviations such as M.C.P.A., D.C.P.A., 2,4-D and 2,4,5-T have been adopted for the variety of complex chemicals involved, and an ever increasing number of trade names are also appearing. This talk will be devoted mainly to a consideration of the possibilities of large scale spraying of cereal crops in Western Australia.

A considerable amount of experimental work on a variety of weeds has been carried out in this State, and some excellent results have been obtained, particularly with cruciferous weeds such as wild turnip, wild radish and mustard. No spraying of crops on a large scale, however, has been conducted locally owing to lack of suitable machinery, and my comments must be based largely on the results of operations in other countries and also experience in Queensland and South Australia.

As these chemicals were developed originally in England, America and Canada, it is natural to look to those countries for figures as a guide to the practical value of the method. The Canadian story, for example, is most interesting. Low volume spraying was introduced to the wheatlands of Western Canada in the spring of 1947. One year later over 4,000,000 acres of crop were treated with 2,4-D weedicides and incomplete reports indicate that this area was largely exceeded in 1949.



A low-volume boom unit.



Showing the boom of the unit above.



Spraying a fairway with a high volume unit.



Hand leads in operation from the above unit.

Such figures immediately prompt a number of questions. What weeds can be handled by this method? When and how is the chemical applied? Is it poisonous or corrosive? Does it damage the crop? And, most important, what are its economical possibilities under the conditions existing in the cereal belt, particularly the wheat belt of Western Australia? Let us answer these questions as far as possible with the information available.

As already mentioned, the most susceptible group of weeds includes the types found most frequently in cereal crops in this State, viz., wild turnip, wild radish and mustard. A variety of other weeds of crops are more resistant, but are checked

to varying degrees by the application. These include double gee, star thistle, cape-weed, Paterson's curse and caltrop. While a high proportion of control of crucifers can result from very low rates of application, only partial control of many other weeds is obtained with increased quantities.

What of the crop itself? It is inadvisable to use quantities in excess of 1 lb. of acid equivalent per acre, and application should not be made during the very early stages of crop growth, preferably not before the six leaf stage of stooling. The sodium salts are usually considered to be most suitable for cereal spraying. If reasonable precautions are taken the risk of permanent crop injury is negligible, as grasses, including cereals, have a high degree of tolerance towards hormone-like weedkillers. The same cannot be said for a number of other crops however, and cases of injury to flax, grape vines, fruit trees and various vegetables are on record.

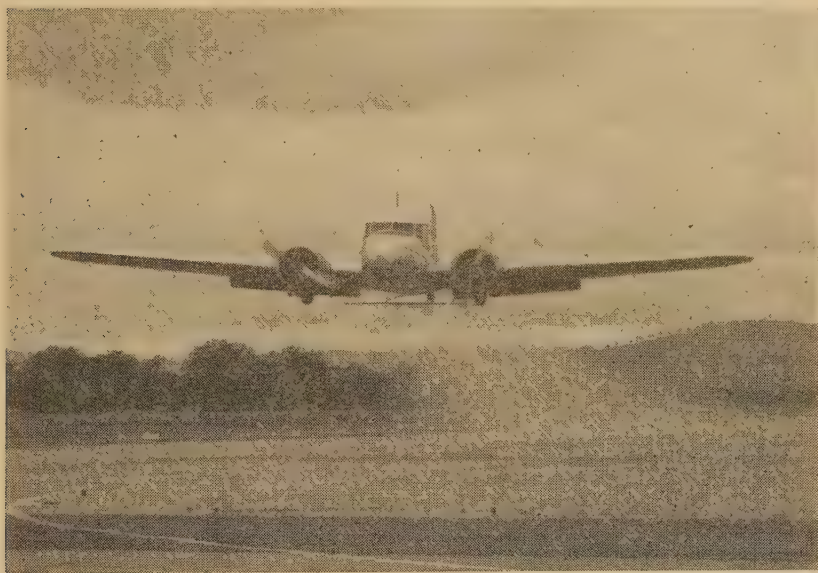


An air blast tunnel type of spray unit.

Obviously, when handling large areas, suitable spray equipment is necessary. When the hormone-like weedkillers were first used, they were applied with high pressure units at rates of 100 gallons per acre and higher. This was the accepted rate for other chemicals used for similar purposes. One does not need to be a mathematician to realise that at that rate at least 10,000 gallons of water would be required to spray a paddock of 100 acres. Even if water is plentiful, quantities of this nature often involve transport problems, especially on soft ground, not to mention the time involved in refilling the spray tank after every few acres. Thus an important limiting factor arose until it was found that low volume applications at low pressure were also effective. The quantity of chemical applied per acre was the important consideration, the volume of water in which it was dissolved being of little consequence provided that coverage of the growth to be killed was obtained. It was found that treatments with as little as five gallons per acre were effective although 10 gallons is the rate used most frequently.

As little as 2½ ounces acid equivalent of the chemical valued at approximately 3s. is regarded as sufficient for the effective treatment of wild turnip, etc.

Two radically different types of machinery have been evolved for the application of chemicals to weeds in crops. One depends on the ejection of the spray through nozzles spaced along a boom, while the other employs a directed air blast to atomize and disperse the solution. Although the boom units vary in detail, particularly in the type of nozzle, the basic construction of the various machines is similar. A pump, geared to the engine of the vehicle or having independent power, forces the weedicide from the tank through the nozzles spaced along the boom which may be as long as 40 feet, although usually shorter. High pressures are not necessary for low volume applications—the accepted method for handling turnip-like weeds in crops. A Melbourne engineering firm has developed small spray cups rotated by individual 12 volt electric motors. The shattering into droplets is caused by centrifugal force and it is claimed that discharge can be regulated down to one gallon per acre. The spray cups are mounted on a boom, but the mechanism is a departure from the standard nozzle type.



Checking spray dispersal at the aerodrome.

In the case of the air blast machine, the solution is pumped through nozzles into the air stream generated by a propeller, which creates a wind speed of approximately 60 miles per hour. The manufacturers claim that the machine will give a reasonably effective distribution over a swathe of 40-60 feet, depending on wind conditions. Naturally the influence of wind is greater with such machines than with the boom type which directs the chemical from a comparatively low level.

Spraying from aeroplanes always has popular appeal, but again, the efficiency is to no small extent dependent on the weather, and a number of other factors, including landing facilities, have to be taken into account.



Spraying water hyacinth with 2,4-D from the air.

Field spraying experiments to be carried out during the coming season will provide first hand information, but already there would appear to be a place for large scale crop spraying in this State in order to combat infestations of wild radish, wild turnip and their relatives, especially where additional cultivation may create erosion problems. For such weeds the cost is not excessive. Suitable low volume spraying equipment can be purchased for about £120. Satisfactory results have been obtained with chemical costing as little as 3s. per acre, and 20 acres can be sprayed in an hour with a moderate sized machine mounted on a utility. Labour, petrol and plant depreciation costs are therefore relatively small.

On the credit side, increased yields can be expected, harvesting difficulties are minimised and there is less risk of dockage for weed seed contaminated grain. Further an improvement in the general weed position on the farm will result.

Cultivation is likely to remain the first line of attack for weed control, but with the discovery of 2,4-D or hormone-like weedkillers and the development of low volume spraying equipment, large scale crop spraying in this State has become a practical possibility.

KIMBERLEY RESEARCH STATION PROGRESS REPORT, 1947-49.

Prepared by the Joint Supervisory Committee.

SYSTEMATIC examination of the irrigation potentialities of lower Ord River region can be said to have commenced with a soil survey made in 1944 by the Western Australian Department of Agriculture. These investigations broadly covered an area of 750,000 acres but a detailed soil survey involving systematic soil sampling and soil analyses, was made of the main areas of alluvial plain suggested as suitable for irrigation. These plains covered an area of 86,000 acres. Of this area 56,000 acres appear potentially irrigable and comprise 44,000 acres of a heavy textured soil such as Cununurra clay and 12,000 acres of light textured levee soils such as Ord sandy loam. Other areas, estimated at 125,000 acres appear, from general reconnaissance, to be commendable and could warrant more detailed investigation should this be proved.

The Kimberley Research Station was established in 1945 to replace and extend the work commenced at the Carlton Reach Experiment Station, about ten miles upstream from the present site. The new station which adjoins the Ord River about 60 miles by road from Wyndham comprises an area of 2,000 acres. The site was selected so that areas of both the Cununurra clay, locally known as the black soil plain, and of the levee soils were included.



View, looking upstream, of the permanent pool in the Ord River from which water is pumped for experimental irrigation.

The research station is concerned with agricultural investigations in the region and the immediate objectives of the programme of research are to determine whether the soils are satisfactory for irrigation and if a stable system of agriculture which will provide a sound basis for the settlement of the area can be developed.



View, looking upstream, of the proposed dam site 50 miles up river from the Research Station.

An agreement exists between the Commonwealth and Western Australian Governments whereby costs are shared, and responsibility is divided between the Commonwealth Scientific and Industrial Research Organisation and the Western Australian Department of Agriculture—the former assuming direction and control of the plant industry research programme, and the latter providing station labour and management and assuming responsibility for research into soil and animal problems as the need arises later in the development of the area.

A committee known as the Kimberley Research Station Supervisory Committee was appointed in 1946 to plan and supervise investigations. The committee is composed as follows:—

C.S.I.R.O.

Mr. C. S. Christian, Principal Research Officer, Chairman.

W.A. Department of Agriculture.

Mr. W. M. Nunn, Executive Officer.

Mr. G. H. Burvill, Commissioner of Soil Conservation.

Dr. L. C. Snook, Animal Nutrition Officer.

Mr. A. R. C. Clifton, O.I.C. Irrigation and his assistant, Mr. H. K. Gibsone,* have been co-opted to assist in planning and preparing irrigation areas and officers from other branches of the Department of Agriculture will take part as work requiring their specialised assistance is included in the programme. Numerous officers of the C.S.I.R.O. have been consulted in planning the details of the research programme.

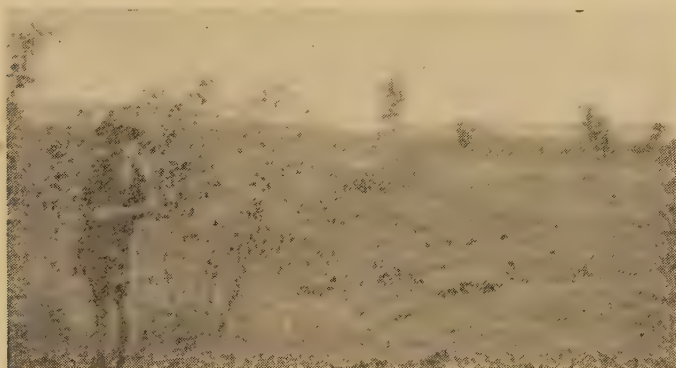
In the memorandum of understanding which was drawn up by the supervisory committee it was indicated that the committee would fully review its activities at the end of a five-year period. However, in view of the interest in the work at the research station, this progress report has been prepared to indicate the results obtained during the first three years of the project.

During the period under review the experiments under the control of this committee which were commenced during the “wet” season of 1947-48 have been in the charge of Mr. E. C. B. Langfield, Technical Officer, C.S.I.R.O.

* Now Officer-in-Charge, Irrigation.

IRRIGATION WATER.

Irrigation water has been supplied by pumping from the Ord River. During the "dry" season this means lifting water from a river pool a height of over 50 ft. and piping it a distance of approximately 30 chains. In the wet season the river rises quickly and irregularly to heights of 40 ft. and floods widely between steep banks. The installation and maintenance of pumps under these conditions, and in such isolation, have presented numerous problems and hazards which have been reflected in breakdowns at periods critical to the success of the trials and in much increased costs of experimentation.



View of black soil experiment area showing natural vegetation prior to commencement of clearing operations in 1946.



Same area receiving first application of irrigation water in June, 1946.

PROJECTS.

Experiments have been designed to obtain factual information concerning the adaptability and production of a wide range of plants falling into the following groups:—

- (1) Major crops which may be disposed of on world markets, e.g. rice, cotton, peanuts, etc.
- (2) Perennial pastures for fattening cattle or for dairying.

- (3) Annual pastures and fodders.
- (4) Minor crops to provide stock feeds and assist soil management and improvement, and special introductions which may be developed as new crops.



A view from the river of the main pumping unit. Water is delivered through a 12in. vertical pipe housed within the cut in the river bank. Smaller pumping unit is on the left, with laboratory in the background.

(Photo. No. 726 of Station Records.)



Water being applied by furrow system to cotton experiments, 1949.

In order that the suitability of any species and possible levels of production might be determined various aspects of growth and cultivation of each species have been examined. Broadly these have concerned

- (1) Comparison of irrigated and non-irrigated plantings.
- (2) Comparison of wet season irrigated, and dry season irrigated plantings.
- (3) Times and rates of plantings.
- (4) Fertiliser requirements.
- (5) Water requirements.
- (6) Comparison of varieties within each crop species.

The experiments have revealed certain difficulties in the region and because of these, the results from the experiments so far completed do not yet permit comprehensive conclusions to be drawn. The following comments summarise the information that has been obtained.

Rice.—The highest yield of paddy rice harvested so far has been at the rate of 11 cwt. per acre. Other plantings have appeared somewhat better but of five experiments sown three have been completely destroyed by birds. Since the first experiment, all have been covered by wire netting but this has failed to protect the crops from small birds such as finches. Because of quarantine restrictions on the import of seed in quantity, use has been made in the preliminary stages of the variety Caloro which is grown widely in the Murrumbidgee Irrigation Area and is available in bulk. It would appear to be too early maturing to make full use of the growth season under irrigation in the tropics and the relatively poor growth of most plantings must in part be attributed to the use of this unsuitable variety. Although it has been replaced by Late Caloro in the last experiment it is evident that varieties still more suitable for tropical conditions must be obtained before a true assessment of the rice growing possibilities of the region can be made.

A number of introduced varieties were planted in small lots in 1948 but were destroyed by birds. Additional material has since been obtained and is now under observation. New material of promising varieties has been secured from New Guinea and is being grown in quarantine. Seed of several varieties from Brazil has also been received.

In all experiments a marked improvement of vegetative growth has occurred in fertiliser plots, the response to superphosphate being most prominent. It is evident that successful rice production of this soil will require the application of superphosphate and possibly other fertilisers.

Although satisfactory yields have not yet been obtained it is considered that the environment is generally sufficiently suitable for rice to warrant further experiments, with particular emphasis on the variety problem.



Two views of rice variety 1949-50 trials. Earlier bays were completely netted. Sections of these will be protected by movable coops.
(Photo. No. 675 of Station Records.) (Photo. No. 664 of Station Records.)

Cotton.—Cotton has been planted as a non-irrigated crop during the wet season and as irrigated crops during both the wet and dry seasons.

Yields from all non-irrigated experiments have been so low as to discourage further plantings of this kind.

Irrigated wet season plantings have made promising growth but in all years they have been severely attacked by grasshoppers. Largely as a result of this, harvested yields have been low, from 300-500 lb. of seed cotton per acre.

Dry season irrigated crops have also shown promising growth and in one instance yielded 1200 lb. seed cotton per acre. However in most dry season plantings severe losses have occurred through damage by rain as the cotton matured. An April planting in 1949 failed to mature any earlier than a June planting of 1948. In both cases the progress of the crops were severely retarded during the cooler months of June and July. Much earlier plantings than April are not always practicable because of difficulties of land preparation during the wet season and because of the prevalence of grasshoppers in February and March. Attention therefore is being directed towards obtaining varieties which may mature more readily under the dry season conditions.

The varieties tested have included Miller Lot 1, Locket 140, and two strains of Oklahoma Triumph. Of these Locket 140 has given the most promising yields. Both Miller Lot 1 and Locket 140 have produced cotton of fair to good commercial quality.

Varieties introduced from Egypt and South America are under observation. Additional strains of Queensland grown varieties are being tested in the search for adapted strains with longer staple and early maturity.

All experiments have given increased yields when superphosphate has been applied. Responses to nitrogen and potash fertilisers have been less definite. Although commercial crops would almost certainly require some form of fertilisation, the most important problem to solve first is the choice of suitable varieties for these special conditions.



1949 dry season irrigated cotton.

(Photo. No. 649 of Station Records.)



1949-50 wet season fertiliser trial with cotton showing severe damage from grasshoppers.

(Photo. No. 713 of Station Records.)

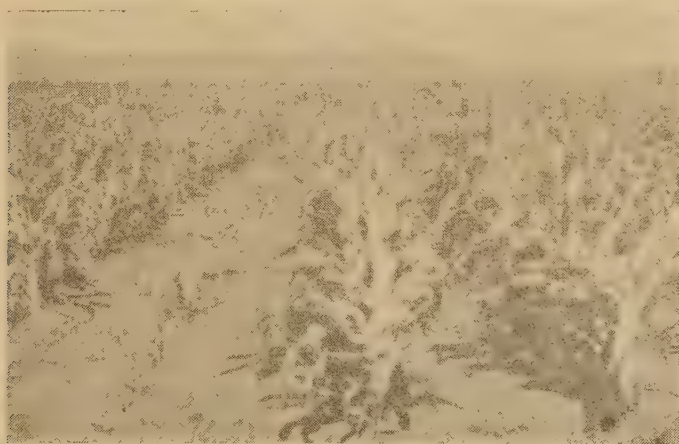
Grain Sorghums.—Grain sorghums have failed to give satisfactory yields without irrigation. Even with supplementary irrigation maximum yields have not been outstanding when compared with the better Queensland areas where the crop is grown on rainfall alone. The highest yields, 60-70 bushels per acre, have been obtained from wet season crops which have been fertilised and irrigated. Comparable treatments during the dry season have not yielded more than 50 bushels per acre. This crop can be matured more satisfactorily during the dry season than cotton but yields are lower than in the wet season. Birds have been troublesome throughout the year but have done more serious and consistent damage to wet season crops. Grasshopper attacks have caused less damage than in the case of cotton but have been of importance during the wet season.

Seven varieties have been compared. Behaviour has varied with the season but Caprock, Kalo, Wheatland and Hegari have been consistently the best yielders.

Grain sorghum has shown markedly improved growth where fertilisers have been applied. The addition of superphosphate at levels of $1\frac{1}{2}$ –2 cwt/ac. has generally doubled yields. In some experiments increased yield has followed applications of ammonium sulphate but only with the lower levels of superphosphate applications (1 and 2 cwt./ac.). Similar responses to potassium sulphate fertiliser have also been observed.

Fertiliser experiments which include numerous minor elements are in progress.

The effects of different row spacings have been examined but conclusive results have not yet been obtained.



1949-50 wet season fertiliser trial with grain sorghum. Note poor growth in "no super" row.
(Photo. No. 694 of Station Records.)

Peanuts.—This has been the most successful of the crops tried with respect to adaptability and relative productivity. However one major difficulty has been the harvesting of the crop from the heavy clay soil and special attention is now being paid to this problem. Reasonably efficient harvests have been obtained in recent experiments. One aspect being examined is the possible use of seed left in the ground as a basis for the establishment, with an oversown grass species of a temporary pasture rotation.

Non-irrigated plantings of this crop have been more successful than other species, the highest yields being in 1948-49 when 800-1,000 lb./ac. were obtained.

Wet season irrigated crops have produced very satisfactory yields, the best fertiliser treatments averaging at the rate of 2450 lb./ac. of hand-harvested nuts in 1948-49.

Dry season irrigated crops have suffered damage by rain before harvest. The 1948 crop gave yields of the order of 700 lb./ac. on fertilised plots. The 1949 crop was abandoned because of excessive rain on the immature nuts.

No responses have been obtained from phosphate, nitrogen or potash when applied alone, but large increases in yields have followed application of phosphate and potash in combination. A trace element fertiliser trial is in progress.

Grasshoppers have damaged most wet season crops. The variety Red Spanish has proved much more susceptible than Virginia Bunch. A grub damaging the nuts, and Witches' Broom disease have both caused some losses.



A good crop of peanuts grown under furrow irrigation as a minor element trial during 1949-50 wet season.

(Photo. No. 716 of Station Records.)

Cowpeas.—Cowpeas have grown satisfactorily during the wet season but have been even more susceptible to grasshopper attacks than cotton. Variety Q33 Reeve has been most promising.

Maize.—Yields from both wet and dry season irrigated crops of hybrid maize and selected varieties have been unsatisfactory due to poor pollination.

Pastures.—An area of 10 acres of irrigated pastures top-dressed with super-phosphate was sown in 1947. These included separate pastures of Rhodes Grass, Para grass, *Paspalum dilatatum*, Guinea grass and Birdwood grass. Half the pastures were sown to *Phaseolus lathyroides* (an annual legume) and half to lucerne. Neither legume survived, the larger proportion of plant losses being due to selective attack by grasshoppers.

Of these grasses most satisfactory growth has been made by Para, Guinea and Rhodes.

All pastures were grazed by young stock towards the end of the dry season of 1949 but the animal response was disappointing. The station will shortly be equipped to obtain regular body weights and the reason for this poor response will be investigated.

Numerous grasses and legumes have been sown in smaller plots for species observations. Later plantings have been grazed by dairy stock.

Of the additional grasses examined, elephant grass, *Paspalum scrobiculatum*, *Cenchrus ciliaris* Type B and *Andropogon gayanus*, have made promising growth.

Of the many legume species examined most have proved particularly susceptible to grasshoppers and many have failed to survive. The least susceptible species has been *Clitoria ternata*. Further investigations of this legume and of *Stylosanthes gracilis*, *S. sundaica* and varieties of peanuts as pasture legumes are being made.

Additional areas of Rhodes grass combined with the above legumes have been planted and it is planned to obtain animal weight records during the coming dry season.



Clitoria ternata in flower.
(Photo. No. 666 of Station Records.)



Guinea grass 7859. A promising strain.
(Photo. No. 667 of Station Records.)

MISCELLANEOUS SPECIES.

Other species being investigated include pigeon peas, guar and bulrush millet and sunflowers. Bulrush millet has made exceptionally good growth during the wet season.

GENERAL NOTES.

Pests.—Various insect pests have attacked crops, mostly during the wet season. In general, satisfactory control has been obtained by spraying with appropriate insecticides. The major exceptions have been species of locusts and grasshoppers which have been very severe on some crops and pasture species. Control for short periods has been secured by baiting but continuous control has not been practicable during the wet season. The pest is of significance in the establishment period of dry season crops, but is less important during the main crop period of the dry season.

Birds have been serious pests of grain and seed crops. The relatively small area of the experiment station is a strong attraction to birds from a wide radius. Cockatoos and finches have been most damaging and have destroyed many experiments. Should agriculture be developed in the region, it is possible that the importance of these pests would diminish as the cultivated area increased. Kangaroos and wallabies are very numerous and have necessitated netting of all experiment areas.

Storms.—Wind storms and excessively heavy rains have damaged experiments at times but not consistently each season. Heavy rains have caused serious soil erosion in parts of the research station. Their occurrence is a factor to be considered.

Time of Planting.—In general the growing of what are normally summer crops during the April-November period has given lower yields than the normal summer period November-March. Cool weather in June and July appears to be responsible for retarded growth in both summer crops and pastures which delays maturity. In the case of cotton, and peanuts, damage by rain before harvest has been serious.

Soil Fertility.—The fertiliser experiments which have been conducted with a range of crops have given some definite indications of the fertility status of the Cununurra clay. Applications of superphosphate appear to be necessary for all crops, nitrogenous and potash fertilisers for some. The position with respect to trace elements is being determined.

Irrigation.—In spite of an annual rainfall averaging nearly 30in. per annum there seems to be little scope for agriculture in the absence of irrigation.

The experiments conducted have indicated that the Cununurra clay soil can be satisfactorily irrigated and that for row crops furrow irrigation has proved more satisfactory than flood irrigation. The work has not been in progress sufficiently long to indicate if continued irrigation will have desirable or undesirable consequences. It has been possible to accurately measure the amount of water applied only in the more recent experiments.

Results indicate that.—

- (a) Rice has required five or more acre feet of water to mature a crop satisfactorily.
- (b) Dry season annual crops have required from 1.0 to 2.7 acre feet.
- (c) The amount of water needed for annual crops (other than rice) during the wet season in some instances has been extremely low. It has varied from 0.15 to 0.71 acre feet.
- (d) Perennial pastures have utilised only about 1.3 acre feet per annum.

The C.S.I.R.O. experiment station at Katherine has assisted the programme of investigations at the Kimberley Research Station by serving as a quarantine area for newly introduced plant material and also as preliminary testing ground for species in Northern Australia. for example, guar, soybeans, rape seed, sun-flowers, etc. Further, tobacco investigations are in progress at Katherine on some similar soils to those at the Kimberley Research Station and many of the results from this preliminary work will be directly applicable to Kimberley conditions.

THE APPLE LEAFHOPPER (*Typhlocyba Frogatti Baker*) AND ITS CONTROL AT DONNYBROOK, WESTERN AUSTRALIA.

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SUMMARY.

1. A detailed study was made of the life history of the Apple Leafhopper at Donnybrook, Western Australia during the 1947-48 season.

2. D.D.T., "Hexone" and Nicotine Sulphate were tested for use in controlling this pest.

3. A technique was developed for sampling the leafhopper population in the nymphal and adult stages.

4. Two Nicotine Sulphate-White Oil sprays applied as indicated will effectively control the Apple Leafhopper.

5. An application of 0.1 per cent. D.D.T. remained toxic to the leafhopper for a period of three weeks from the time of application.

6. One D.D.T. spray applied when the first winged leafhoppers appear is more effective than one Nicotine Sulphate-White Oil treatment applied at the same time and equal to the two Nicotine Sulphate-White Oil treatments originally recommended.

7. In this experiment the application of D.D.T. did not cause an increase in Bryobia Mite population.

8. D.D.T. sprays as applied in this experiment did not adversely affect the biological control of Woolly Aphis by *Aphelinus mali* or *Leis conformis*.

9. There is need for further trials to test the effect of—

(a) delaying one D.D.T. application for 1-2 weeks;

(b) applying two D.D.T. sprays one at "normal" time and one three weeks later.

10. An initial adverse effect was found to result from the combination of D.D.T. and "Hexone" and this combined spray is not recommended.

11. Nicotine Sulphate in two applications and "Hexone" applied three weeks after normal D.D.T. spray were both effective in reducing the Bryobia Mite population.

INTRODUCTION.

The Apple Leafhopper, Apple Jassid or Canary fly (*Typhlocyba frogatti* Baker) was first recorded in Western Australia at Bridgetown in 1942 (Jenkins 1943) and since that time has spread rapidly throughout the apple growing areas of the lower South-West.

During 1943 orchardists were advised to use two sprays consisting of Nicotine Sulphate 1 pint, White Spraying Oil 1 gallon and water 80 gallons. The first spray to be applied when the earliest hatched jassids reached maturity and before they were ready to lay eggs, and the second spray to follow three weeks later.

However, during the war supplies of Nicotine Sulphate became very short, and none was available for use against the Apple Jassid. Trials carried out with D.D.T. (Jenkins and Forte 1946) indicated that good results were possible with one spray of this insecticide, and it was then decided to conduct an experiment during the 1947-48 season to determine the effectiveness of various D.D.T. treatments, and the relative merits of D.D.T. and Nicotine Sulphate for Apple Jassid control.

LOCATION.

The experiment was laid down on a property at Donnybrook which is one of the principal apple growing districts in the State and where the leafhopper is firmly established.

PREVIOUS HISTORY.

The Apple Jassid was first recorded on this orchard in 1942 and during 1946 the jassid population on the trees was very heavy. In February, 1946, D.D.T. dusts and sprays were applied by the owner in an attempt to check the ravages of the pest.

A winter spray of Red Oil had been used for many years for Bryobia Mite control.

Woolly Aphis was a serious pest in the early history of the orchard, but the introduction of *Aphelinus mali* and *Leis conformis* effected a reasonable control of the pest. Infestations occur on new wood each season, and Woolly Aphis activity is noted up to January, but owing to predator and parasite activity from this time onwards the Woolly Aphis is usually kept in check.

TREATMENTS.

The following treatments were applied:—

- A. Control—no treatment.
- B. A spray containing Nicotine Sulphate 1 pint, White Oil 1 gallon, water 80 gallons applied at *normal time followed by a similar spray three weeks later.
- C. A pre-bud-burst D.D.T. spray containing 0.1 per cent. p.p. isomer D.D.T. applied when the first nymphs emerged from the overwintering eggs, followed by a 0.1 per cent. p.p. D.D.T. spray at *normal time.
- D. A spray containing 0.1 per cent. p.p. D.D.T. applied at the *normal time, followed three weeks later by a spray containing "Hexone" (Hexaethyltetraphosphate) at the concentration of 1 pint in 80 gallons of water.

- E. A combination spray of 0.1 per cent. p.p. D.D.T. containing 1 pint of "Hexone" per 80 gallons of spray.
- F. A spray containing 0.1 per cent. p.p. D.D.T. applied at the *normal time
- G. A pre-bud-burst spray containing 0.1 per cent p.p. D.D.T. applied at the same time as the first spray in C.

*Normal time refers to the stage at which the first adult hoppers appear in the trees, and before they have become sufficiently mature to lay eggs. (Jenkins, 1943.)

LAYOUT.

The experiment was designed as a randomised block, consisting of 7 treatments and 5 replications. Each plot consisted of 12 trees, the two centre sample trees being surrounded by 10 buffer trees, as shown in Fig. 1:—

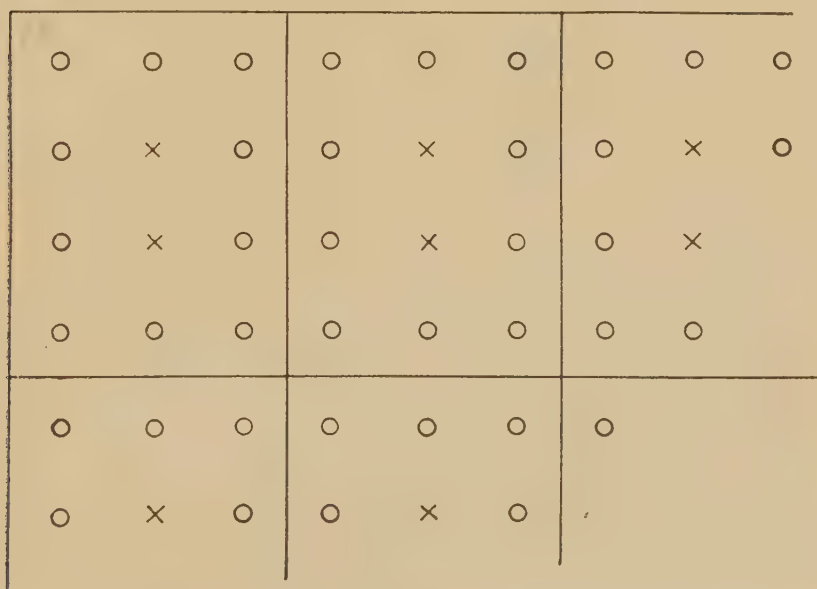


Fig. 1.—Arrangement of sample and buffer trees in plots. X denotes sample trees, O denotes buffer trees and lines outline plots.

Blocks I, II, III, IV were situated in one portion of the orchard and Block V in another section.

VARIETIES.

Blocks I, II, III and IV, consisted mainly of the variety Granny Smith, with a few Delicious and Yates scattered throughout. Block V consisted entirely of Yates.

SPRAYING.

The treatments were applied by means of a power spray, which was normally used on the orchard and maintained a pressure of 200-250 lb. sq. inch. The application of the spray was carried out by the owner (Mr. Parke) and his assistant.

Sprays were applied on the following dates:—

2/10/47. Pre-bud-burst D.D.T. to treatments C and G. At this time just a few buds were bursting on the trees, and a few first instar nymphs were observed on the young leaves. (See life history graph).

5/11/47. Treatments B, C, D, E, and F. This was considered as "normal time." At this time the first adult jassids were showing on the trees. This period occurred one week after full flowering and just after petal fall. (See life history graph).

26/11/47. Nicotine Sulphate to treatment B and "Hexone" to treatment D.

The sprays in each case were applied by the same operators and at the rate of approximately two gallons per tree, and all 12 trees in each plot were given the same spray treatment.

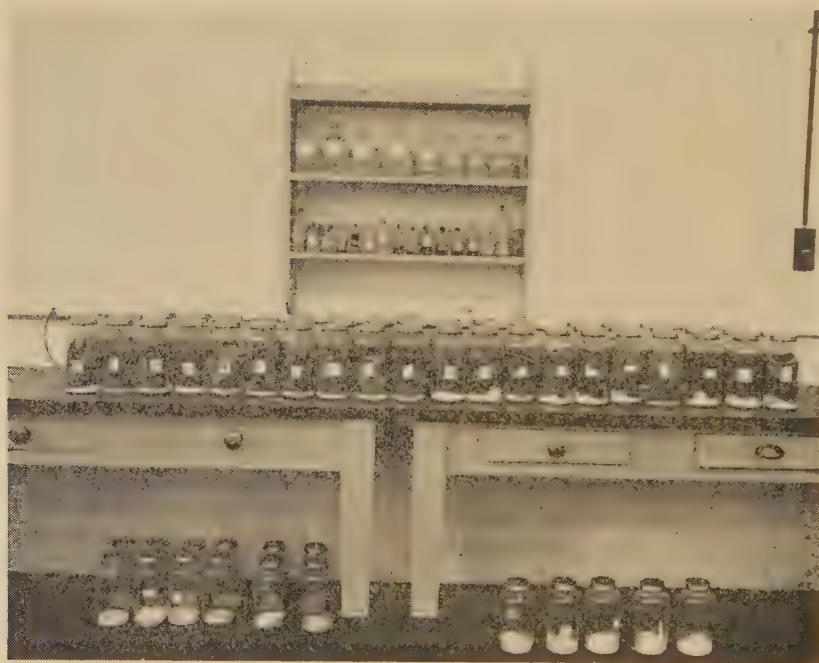


Fig. 2.—Jars containings leaves from one sampling. The empty jars below represent a portion of the sample which has been examined.

SAMPLING.

In estimating the results of the treatments, it was decided to sample the population of jassids present on the trees at various times. The method of sampling was modified from that used by Hartzell and Horsfall (1944) and may be briefly outlined as follows:—

Half gallon screw top glass jars were used throughout and $\frac{1}{2}$ inch of plaster of paris was set in the bottom of each jar. These jars were then charged with ethyl acetate just prior to sampling.

By placing the jar beneath the leaf to be sampled and carefully cutting through the petiole of the leaf with a sharp scissors, it was possible to sample the nymph population during the daytime.

Because of the possible varying attractiveness of different parts of the tree to jassids, a stratified method of leaf collection was adopted at each sampling—equal numbers of leaves being taken from the upper, the middle and the lower portions of the tree.

Thirty-two sample leaves were taken at random from all sides of the tree in each stratum, making ninety-six leaves per tree.



Fig. 3.—The removal of an apple leaf from the upper strata into a sampling jar.

When the jassids became adult, it was found that daytime sampling was impracticable as the jassids were then too active in the trees. Consequently, it was necessary to sample at night when the temperature dropped low enough to restrict jassid activity. This temperature was found to be 55 deg. F. or lower near the ground at the base of the tree.

Immediately a sample was taken the lid was screwed on to the jar and next morning the contents of each jar were carefully emptied into paper bags and transported to the Laboratory for counting. Fig. 2 shows a portion of one sampling in the jars and Figs. 3, 4 and 5 show the methods of removing the samples from the top, middle and lower strata of the tree.



Fig. 4.—The removal of an apple leaf from the middle strata into a sampling jar.

In the Laboratory the samples were emptied on to a glass plate and each leaf was brushed with a camel hair brush. The dead insects on the plates were then transferred to a square slide and counted under a binocular microscope using 19 diameter magnification (Figs. 6 and 7).



Fig. 5.—The removal of an apple leaf from the lower strata into a sampling jar.

Number of leaves per sample.

In order to test the validity of the sampling method and to determine the number of leaves required per sample, a uniformity trial was conducted on the experimental trees just before the application of the "normal time" sprays.

Four samples were taken from each tree, and each sample consisted of eight upper, eight middle and eight lower leaves. The analysis showed that the sampling method was suitable and the results within blocks were uniform.

A second method of estimating the effectiveness of treatments was used at the conclusion of the experiment. Twigs approximately 15 inches long were pruned from the new season's wood, five twigs being taken from the upper portion of the tree and five from the lower. The twigs were cut into three inch lengths and five of these lengths were drawn off as a sub sample. A microscopic count was then made of the eggs present in each sub sample.



Fig. 6.—The method of brushing leaves on to a glass plate before counting.

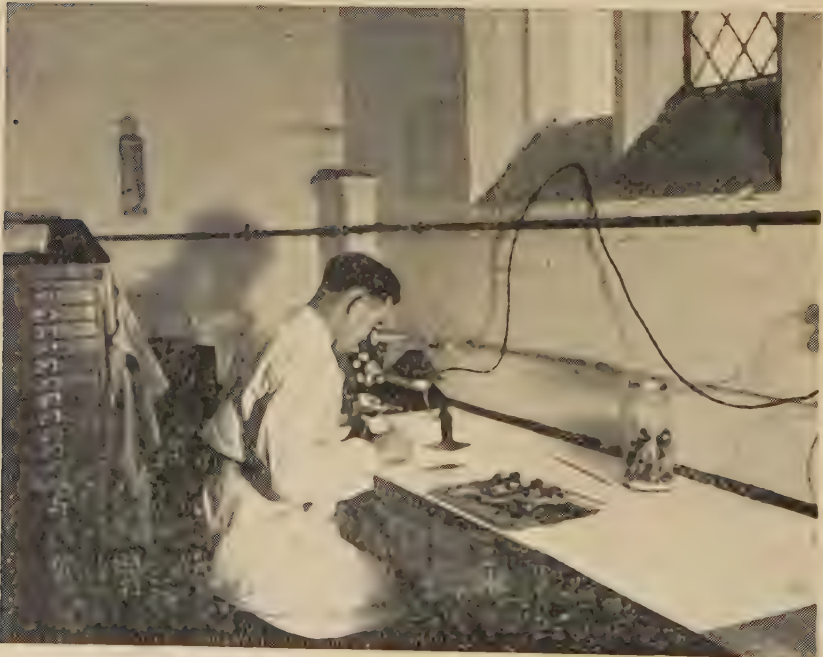


Fig. 7.—Counting the jassids by means of a binocular microscope.

Times of Sampling.

Samples were taken on the following dates which may be related to the jassid population by reference to the life history graph:—

1. 4/11/47—Sampling for uniformity—before the application of the “normal time” sprays.
2. 7/11/47—This took place 24 hours after the spraying. It was necessary to allow this period to pass to make sure that dead nymphs which had been killed by the treatments would have time to fall or be blown off the leaves.
3. 25/11/47—Immediately before the application of the final sprays.
4. 27/11/47—24 hours after the final spraying. This was a part sample—only those trees which were sprayed on 26/11/47 being sampled.
5. 16/12/47—At this stage practically all of the jassids on the trees were adult.
6. 10/2/48—This sampling related to the second generation of jassids.
7. 10/3/48—Also a second generation sampling.
8. 28/4/48—Only a few jassids remained on the trees at this time.
9. 24/6/48—*Egg Count* on twigs.

Results:—

The results of the various samplings were submitted for statistical analysis. Significance was obtained by means of a square root transformation, and the differences required for significance refer to the transformed data. Tables I to XII show the analysis of the various jassid counts.

As sample 1 was analysed on a sample basis (4 samples per tree) and the others on a tree basis (1 sample per tree), the transformed data from sample 1 is not comparable with that from successive samples.

TABLE I.

Sample No. 1. 4-11-47—Entirely Nymphs.

Mean No. of Jassids per Plot (Treatment means)	A. 174.0	B. 294.8	C. 26.0	D. 173.8	E. 241.8	F. 200.4	G. 10.6	S.D.
Treatment Means Transformed data	35.150	43.886	(10.432)	35.416	39.222	36.602	(7.12)	4.3876

S.D. of difference of 2 Treatment means—6.204.

Least significant difference of means at 5 per cent. level—13.152.

Least significant difference of means at 1 per cent. level—18.116.

TABLE II.

Sample No. 2. 7-11-47—Entirely Nymphs.

Mean No. of Jassids per Plot (Treatment means)	A. 129.8	B. 39.2	C. 2.0	D. 17.4	E. 49.0	F. 15.2	G. 10.2	S.D.
Treatment Means Transformed Data	15.138	8.218	1.364	5.102	8.90	4.512	3.678	1.1202

S.D. of difference of 2 Treatment means—1.584.

Least significant difference of means at 5 per cent. level—3.263.

Least significant difference of means at 1 per cent. level—4.435.

Least significant difference of means at 0.1 per cent. level—5.94.

TABLE III.

Sample No. 3. 25-11-47—Nymphs except for few adults.

Mean No. of Jassids per Plot (Treatment means)	A. 110.6	B. 4.6	C. 2.4	D. 1.2	E. 1.8	F. 1.2	G. 13.0	S.D.
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This sample was unsuitable for statistical analysis but clearly all treatments were superior to the control and treatment G. is losing its effectiveness.

TABLE IV.

Sample No. 4. 27-11-47—Nymphs except for few adults.

Mean No. of Jassids per Plot (Treatment means)	A.	B. 2.6	C.	D. 0.6	E.	F.	G.	S.D.
Treatment Means Transformed Data		1.812	....	.481	....	....	....	.3155

S.D. of difference of 2 Treatment means—0.446.

$$\bar{x}_B - \bar{x}_D = 1.331$$

$$t = 4.22^* \text{ with 4 DF } .01 < P < .05.$$

TABLE V.

Sample No. 5. 16-12-47—Nymphs and Adults.

Mean No. of Jassids per Plot (Treatment means)	A. 66.0	B. 4.6	C. 1.6	D. 2.2	E. 2.2	F. 2.8	G. 16.8	S.D.
Treatment Means Transformed Data	11.372	2.73	1.246	1.648	1.33	1.854	5.652	.5120

S.D. of difference of 2 means—0.724.

Least significant difference of 2 means at 5 per cent. level—1.491.

Least significant difference of 2 means at 1 per cent. level—2.027.

Least significant difference of 2 means at 0.1 per cent. level—2.715.

TABLE VI.

Sample No. 6a. 10-2-48—Nymphs.

Mean No. of Nymphs per Plot (Treatment means)	A. 376.6	B. 21.8	C. 49.2	D. 14.4	E. 16.2	F. 16.6	G. 96.6	S.D.
Treatment Means Transformed Data	27.006	5.628	7.23	5.568	5.212	5.076	13.328	1.4289

S.D. of difference at 2 Treatment means—2.021.

Least significant difference of 2 means at 5 per cent. level—4.163.

Least significant difference of 2 means at 1 per cent. level—5.659.

Least significant difference of 2 means at 0.1 per cent. level—7.579.

TABLE VII.

Sample No. 6b. 10-2-48—Adults.

Mean No. of Adults per Plot (Treatment means)	A. 42.2	B. 2.8	C. 11.0	D. 5.2	E. 5.6	F. 5.8	G. 19.4	S.D.
Treatment Means Transformed Data	8.558	1.910	3.384	2.096	2.266	2.490	6.026	.7685

S.D. of difference of 2 Treatment means—1.087.

Least significant difference of 2 means at 5 per cent. level—2.239.

Least significant difference of 2 means at 1 per cent. level—3.044.

Least significant difference of 2 means at 0.1 per cent. level—4.076.

TABLE VIII.

Sample No. 6c. 10-2-48—Total.

Mean No. of Jassids per Plot (Treatment means)	A. 418.8	B. 24.6	C. 60.2	D. 25.6	E. 20.8	F. 22.4	G. 112.0	S.D.
Treatment Means Transformed Data	28.49	6.10	8.12	6.09	5.83	5.90	14.41	1.4289

S.D. of difference of 2 Treatment means—1.985.

Least significant difference of 2 means at 5 per cent. level—4.089.

Least significant difference of 2 means at 1 per cent. level—5.558.

Least significant difference of 2 means at 0.1 per cent. level—7.444.

TABLE IX.

Sample No. 7a. 10-3-48—Nymphs.

Mean No. of Nymphs per Plot (Treatment means)	A. 121.2	B. 14.8	C. 26.4	D. 11.2	E. 19.4	F. 14.0	G. 67.8	S.D.
Treatment Means Transformed Data	15.33	5.03	5.89	3.55	4.57	4.61	11.56	1.148

S.D. of difference of 2 Treatment means—1.624.

Least significant difference of 2 means at 5 per cent. level—3.345.

Least significant difference of 2 means at 1 per cent. level—4.547.

Least significant difference of 2 means at 0.1 per cent. level—6.090.

TABLE X.

Sample No. 7b. 10-3-48—Adults.

Mean No. of Adults per Plot (Treatment means)	A. 77.4	B. 16.4	C. 32.2	D. 20.2	E. 25.8	F. 18.0	G. 59.0	S.D.
Treatment Means Transformed Data	11.96	5.04	6.73	5.18	6.21	5.13	9.37	.6693

S.D. of difference of 2 Treatment means—0.989.

Least significant difference of 2 means at 5 per cent. level—2.037.

Least significant difference of 2 means at 1 per cent. level—2.769.

Least significant difference of 2 means at 0.1 per cent. level—3.709.

TABLE XI.

Sample No. 7c. 10-3-48—Total.

Mean No. of Jassids per Plot (Treatment means)	A. 194.6	B. 31.2	C. 58.6	D. 31.4	E. 55.2	F. 32.0	G. 116.8	S.D.
Treatment Means Transformed Data	19.62	7.29	9.07	6.44	7.94	6.93	15.05	1.2071

S.D. of difference of 2 Treatment means—1.707.

Least significant difference of 2 means at 5 per cent. level—3.516.

Least significant difference of 2 means at 1 per cent. level—4.780.

Least significant difference of 2 means at 0.1 per cent. level—6.401.

TABLE XII.

Sample No. 9. 24-6-48—Egg Count.

Mean No. per Plot (Treatment means)	A. 341.4	B. 104.0	C. 177.6	D. 77.6	E. 155.8	F. 93.8	G. 191.6	S.D.
Treatment Means Transformed Data	33.228	19.372	22.524	15.728	21.668	17.680	25.772	2.6371

S.D. of difference of 2 Treatment means—3.730.

Least significant difference of 2 means at 5 per cent. level—7.684.

Least significant difference of 2 means at 1 per cent. level—10.444.

Least significant difference of 2 means at 0.1 per cent. level—13.988.

DISCUSSION.

Nicotine Sulphate.

Treatment B consisted of two applications of Nicotine Sulphate and White Oil—the first application being made when the first adult jassids appeared and being followed by a second application three weeks later.

This treatment proved to be very effective in reducing the jassid numbers in both generations and so caused a significant reduction in the number of overwintering eggs laid in the young wood at the end of the season.

Before treatment the mean number of jassids per plot on treatment B was 298.4 (Table I) and after the first application of Nicotine Sulphate it was 39.2 (Table II). On the control plots the reduction in the mean number per plot was from 174.0 to 126.8. This reduction on treatment B as compared with that on the control plots was highly significant (0.1 per cent. level).

Sample No. 2 was taken 24 hours after the first application of the Nicotine Sulphate—White Oil treatments and the contact effect of treatment should have shown its maximum effect by that time. It is important to note that the Nicotine Sulphate treatment was not effective in controlling all of the jassids present on the tree at that time, since this sample showed the presence of third and fourth instar nymphs.

Further evidence of this failure to obtain 100 per cent. control of jassids is demonstrated by the fact that the pre-bud-burst D.D.T. spray (in treatment C and G) was significantly superior to treatment B (at 1 per cent. level) when sample 2 was taken. (See Table II.)

After the second application of Nicotine Sulphate, a further reduction of jassids in the trees occurred with the result that the mean number of jassids per plot was 2.6. The jassids remaining in the sample were found to be both adults and nymphs, indicating that whilst the mortality due to the Nicotine Sulphate—White Oil was very high, it did not give 100 per cent. control.

The D.D.T. Treatments.

D.D.T. treatments were used at two stages in the life history of the insect. Firstly, as a pre-bud-burst spray applied when the first nymphs were hatching from the overwintering eggs, and secondly when the first hatched nymphs were reaching maturity and before egg laying had commenced (see life history graph). The various D.D.T. treatments were as follows:—

Pre-bud-burst D.D.T. alone (treatment G).

Pre-bud-burst D.D.T. followed by D.D.T. at normal time (treatment C).

D.D.T.—normal time (treatment F).

D.D.T.—normal time followed by “Hexone” three weeks later (treatment D).

Combined D.D.T. and “Hexone” at normal time (treatment E).

(i) Pre-bud-burst D.D.T. (Treatment G).

This treatment was very effective in controlling the early hatched jassids, and at the time of the first sampling this treatment had obviously caused a very great reduction in the population. The mean number of jassids per plot being 10.6, as compared with 174 from the controls receiving no treatment. (See Table I).

All jassids counted in this first sample from Treatment G were found to be first and second instar nymphs. The second instar nymphs were only a few days old and, as jassids were emerging over the whole period, it was obvious that this treatment had been very effective in killing off the jassids as they emerged. The presence of second instar nymphs, however, showed this treatment was beginning to lose its effectiveness at this stage—that is, one month after application.

Owing to the small numbers involved in the treatments, sample 3 was unsuitable for analysis, but it was obvious from the figures that pre-bud-burst D.D.T. spray (treatment G) was losing its effectiveness. The fact that such a build-up has occurred in this treatment indicates that:—

1. The effectiveness of the D.D.T. apparently ceased at least 3-4 weeks prior to this sampling since a high proportion of the observed jassids were adult.

2. The jassids were still hatching after this treatment had ceased to be highly effective.
3. The D.D.T. in this treatment (applied on 2/10/47) had apparently ceased to be effective by 25-30/10/47.

From observations made on 27/10/47 this reduction in the effectiveness of the D.D.T. cover dated from approximately 27/10/47 when a very few nymphs had succeeded in reaching the second instar and were therefore only a few days old.

This loss of effectiveness was further demonstrated in the subsequent samplings 5, 6 and 7 (see Tables V, VIII, XI) in which all other treatments excepting the control were superior to this single pre-bud-burst D.D.T. spray at a 0.1 per cent. level of significance. Also, analysis of eggs laid at the end of the season showed that this treatment was little better than the control. (See Table XII.)

(ii) *Pré-bud-burst D.D.T. followed by D.D.T. at "normal time" (Treatment C).*

This treatment proved to be very effective in controlling jassids and was significantly superior to the control at all samplings, at the 0.1 per cent. level.

Up to the time of the second sampling this treatment was the same as the single pre-bud-burst D.D.T. spray (Treatment G). After the application of the second spray, there appeared to be a reduction in the number of jassids on this treatment as compared with G, but the difference was not significant. At the fifth sampling (16/12/47) this treatment had become significantly superior to treatment G.

The egg counts at the end of the season revealed that this treatment gave a significant reduction in the number of eggs laid in the wood as compared with the control at the 1 per cent level. (Table XII.)

Treatments D, E and F each received an application of D.D.T. at the normal time—in the case of E the D.D.T. was combined with "Hexone," and in the case of D "Hexone" was applied three weeks later.

Apart from the initial depressing effect which resulted apparently from the combination of "Hexone" with D.D.T. (which is discussed later) there did not appear to be any important difference between the three treatments in the control of jassids.

The application of D.D.T. at this time was very effective in controlling the jassids and was significantly superior to the control and also to treatment G. This reduction in jassid population was also evident from the egg counts. (Table XII.)

Nicotine Sulphate Compared with D.D.T.

From a comparison of B, F and C it is evident that one D.D.T. spray applied at normal time was just as effective as two Nicotine Sulphate sprays, one at normal time and one 3 weeks later.

The Nicotine Sulphate spray would show its maximum effect within 24 hours of application, but from a comparison of treatment F and B, the single D.D.T. treatment was more effective than the Nicotine Sulphate after 24 hours (see Table II) and has been shown to remain toxic for approximately three weeks.

"Hexone" Treatment.

The addition of "Hexone" in combination with D.D.T. at the normal time and when applied separately three weeks after the normal time D.D.T. spray gave no better results than a single spray of D.D.T. at the normal time, and in fact when combined with D.D.T. gave a lower immediate kill than that obtained by using D.D.T. alone at the same strength. (See Table II.)

ECONOMICS.

That the Apple Leafhopper is a pest of economic importance to apple growers where it occurs is generally accepted.

Marshall (1942) has shown that permanent damage to cell structure and the capacity of leaf to function properly can result from leafhopper attack on apple leaves, although no information on the cumulative effect over a period of years in the thriftiness of the tree is available.

In Western Australia the obvious loss to the grower is by the disfigurement of the fruit which may cause it to be degraded.

From the tables submitted it will be seen that one D.D.T. spray was equally as good as the recommended Nicotine Sulphate spray programme involving two applications.

The D.D.T. spray will be applied after petal fall, so that bees would not be affected and the application time would co-incide with that recommended for controlling looper caterpillar, and spring beetle, against which pests D.D.T. is also effective.

At the present prices of the two commodities—two Nicotine Sulphate applications would cost much more than a single D.D.T. spray apart from the double application costs involved in the Nicotine Sulphate programme.

NEED FOR FURTHER TRIALS.

The present experiment has shown that D.D.T. is very effective in its control of the jassid and that it remains toxic to the emerging nymphs for a period of approximately three weeks.

The latest application of D.D.T. in this experiment occurred at the "normal time" (6th November in this instance) and could be expected to remain effective until approximately 27th November whereas egg hatching continued until the first week in December, and it is expected that some eggs may have hatched after the D.D.T. spray had lost its effectiveness.

This may be more clearly shown by reference to the life history graph, where the "normal time" spray application is shown by the line N. and its probable period of effectiveness is shown as the space between the two lines N. and O.

To obtain an even greater degree of control, two suggestions may be made:—

1. That the application of the "normal time" spray should be delayed for at least two weeks so that its period of effectiveness will extend a further fortnight. This would appear sufficient to give very good jassid control providing that adults of the first generation were unable to lay eggs before the 1st December. This spray timing is shown graphically on the life history graph as the line Y. The toxic cover provided by this spray should remain effective for the space between the lines Y. and Z.

2. That two applications of D.D.T. spray should be applied—one at the normal time and the second three weeks later. This would provide a period of effectiveness of approximately six weeks from the normal time (7th November), and would mean that the trees would be provided with a toxic covering until the overwintering eggs had ceased hatching. The application of these proposed sprays are shown graphically as the lines X and Y. It is expected that the application at X would remain toxic over the space between the lines X and Y and that the application at Y would remain toxic over the space between Y and Z.

The effect of such a treatment on Bryobia Mite and Woolly Aphis is unknown and would have to be determined experimentally.

EFFECT OF TREATMENTS ON OTHER HORTICULTURAL PESTS.

Bryobia Mites.

A dormant spray had been applied for control of this pest which resulted in a light infestation during the season.

Counts were made of mites occurring in samples 6, 7 and 8 (see Tables XIII, XIV and XV). Statistical analysis of these figures revealed that:—

1. The use of D.D.T. in any of the treatments did not significantly increase the population of mites.
2. Nicotine Sulphate—White Oil gave a significant reduction over the control and also the D.D.T. treatment.
3. "Hexone" in Treatment E gave a reduction in the mite population as compared with the control.

In addition to the jassid sampling, counts were also made of the numbers of Bryobia Mites present throughout the season, and a summary of these figures together with the analysis of variance is given in Tables XIII, XIV and XV.

TABLE XIII.

Sample No. 6. 10-2-48—Mites.

Mean No. of Mites per Plot (Treatment means)	A. 207.0	B. 40.4	C. 98.4	D. 165.8	E. 69.6	F. 199.6	G. 127.6	S.D.
Treatment Means Transformed Data	18.09	7.23	11.92	16.99	9.69	18.69	14.83	2.7029

S.D. of difference of 2 Treatment means—3.831.

Least significant difference of 2 means at 5 per cent. level—7.892.

Least significant difference of 2 means at 1 per cent. level—10.727.

Least significant difference of 2 means at 0.1 per cent. level—14.366.

TABLE XIV.

Sample No. 7. 10-3-48—Mites.

Mean No. of Mites per Plot (Treatment means)	A. 168.4	B. 144.8	C. 110.0	D. 138.0	E. 111.0	F. 123.4	G. 120.0	S.D.
Treatment Means Transformed Data	17.072	16.678	13.752	16.038	14.572	15.180	14.542	1.8632

S.D. of difference of 2 Treatment means—2.365.

Least significant difference of 2 means at 5 per cent. level—5.428.

Least significant difference of 2 means at 1 per cent. level—7.378.

Least significant difference of 2 means at 0.1 per cent. level—9.881.

TABLE XV.

Sample No. 8. 28-4-48—Mites.

Mean No. of Mites per Plot (Treatment means)	A. 8.2	B. 0.4	C. 1.4	D. 1.6	E. 2.4	F. 3.4	G. 2.8	S.D.
Treatment Means Transformed Data	2.624	0.282	1.046	1.092	1.082	1.986	1.694	.6422

S.D. of difference of 2 Treatment means—·908.
Least significant difference of 2 means at 5 per cent. level—1.870.
Least significant difference of 2 means at 1 per cent. level—
Least significant difference of 2 means at 0.1 per cent. level—

Woolly Aphis.

From observations made throughout the period of the experiment, the Woolly Aphis population followed the trend noticed in other years by Mr. Parke. The population built up to a maximum towards the end of January on all treatments, but was later completely controlled by the activity of *Leis conformis* and *Aphelinus mali* on all treatments including those receiving the D.D.T. spray.

APPENDIX.

Life History of Apple Leafhopper.

The detailed sampling necessary during the foregoing experiment gave an excellent opportunity for studying in detail the life history of the leafhopper. The efficiency of the various treatments depends largely upon the timing of the applications in relationship to the insects' development, and so an outline of the life history investigations are included in this paper.

First Generation.

The jassid overwinters as eggs in the young wood. During the 1947-48 season, observations were made of the stages in the life history of this insect.

The overwintering eggs commenced hatching about 30/9/47, and the hatching continued until about 30/11/47. Nymphs were present until the third week in December. The first adults were observed on 3rd November, that is about five weeks from the first hatching.

First generation adults continued to be present until at least the third week in January.

Egg laying was not observed, but it has been reported (Dumbleton 1934) that egg laying commences about four weeks after the insects become adult and so egg laying is expected to have commenced about the beginning of December.

Second Generation.

The first nymphs of the second generation to emerge were observed on the 20/1/48. Then present were first and second instar nymphs. It was found that nymphs were present until the end of March. The time from egg laying to emergence appears to be about six weeks.

The adults of the second generation were first observed on the 10th February, and adults were present until the end of April. The period from hatching to adult appears to occupy about three weeks.

By the end of April the numbers of jassids were greatly reduced and only a very few were observed on the trees.

Attached is a graph showing the approximate life history on the control plots. (See Fig. 8.)

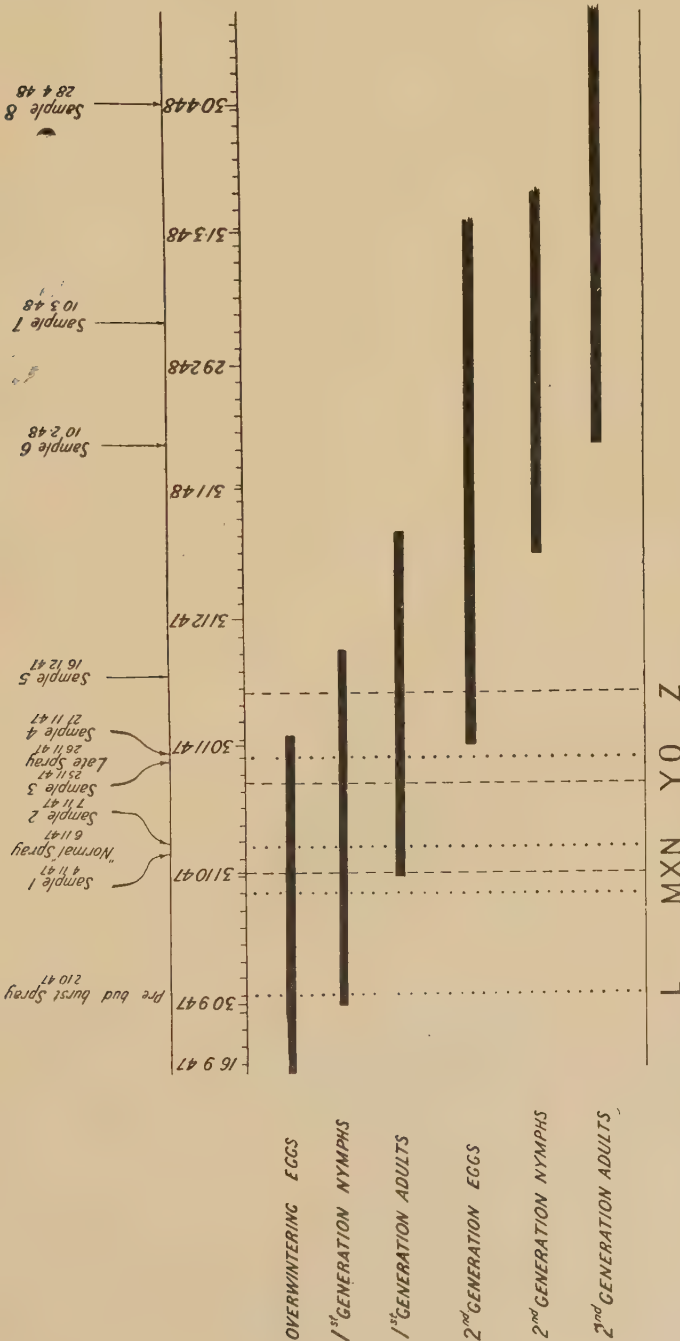


Fig. 8.—Graphical representation of the life history of the apple jassid on the experimental orchard at Donnybrook during 1947-48 season. L (dotted line) denotes the application of pre-bud burst D.D.T. spray and L-M the period it remained effective. N (dotted line) denotes the application of "normal" time D.D.T. spray, and N-O the period it remained effective. A single D.D.T. spray at Y (broken line) would be expected to remain effective over the period Y-Z or a D.D.T. spray at X (broken line) followed by a second D.D.T. spray at Y (broken line) would be expected to remain effective over the period X-Z.

ACKNOWLEDGMENTS.

The authors wish gratefully to acknowledge the assistance given by Mr. Cornish, Officer-in-Charge, Section of Mathematical Statistics for assisting in planning the experimental layout and analysing the samples obtained. Also Mr. G. Parke, on whose property the experiment was conducted, and for the valuable aid rendered by him and his assistant in applying the treatments.

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TRIALS WITH NEW INSECTICIDES IN FRUIT FLY CONTROL.

By F. E. RYAN, Assistant Entomologist. E.M.

SUMMARY.

AN account is given of a number of trials with new insecticides carried out from 0.156 per cent. to 0.025 per cent. of gamma isomer were shown to be more in the control of Fruit Fly (*Ceratitis capitata* Weid.) in Western Australia.

In cage baiting trials in the laboratory benzene-hexachloride baits containing rapid in their knockdown than sodium fluosilicate and "Hexone." D.D.T. at concentrations of 0.156 per cent. was not so rapid in its knockdown as sodium fluosilicate.

In field trials a rapid knockdown of fruit flies with B.H.C. baits was demonstrated and in a field experiment B.H.C. baits containing 0.05 per cent. gamma isomer gave good results, as compared with sodium fluosilicate and E.605, in reducing the number of fly strikes in navel oranges.

In laboratory trials benzene-hexachloride incorporated with the soil was shown to be toxic to the larvae of fruit fly and further trials are necessary to demonstrate concentrations suitable for use in the field.

Heavy applications of benzene-hexachloride in pits in which infested material was placed, prevented the full development of the flies and further trials are needed to show suitable applications for use in orchards.

Some remarks have been included concerning the variation of the fruit fly population and the difficulties associated with obtaining valid results from trials with this insect in the field.

INTRODUCTION.

The Mediterranean Fruit Fly (*Ceratitis capitata* Weid.) is one of the most serious of the orchard pests in Western Australia. Routine control measures for this pest are strict attention to orchard hygiene, especially the gathering and destruction of fallen fruit, and the use of foliage bait at weekly or more frequent intervals. The bait consists of 1 oz. of sodium fluosilicate and 2½ lb. of white sugar in 4 gallons of water.

The discovery of the insecticidal properties of D.D.T. and benzene-hexachloride suggested that improvements in the existing control measures might be possible and that new methods of control might be practicable. Possible applications of new insecticides include—

1. Their use in preparation of new baits which would be more rapid in their action than sodium fluosilicate.
2. Their use as cover sprays which would be toxic to flies alighting in treated trees.
3. Their use as a soil dressing for control of maggots entering and adult flies leaving the soil.
4. Their use in preventing the development of maggots present in infested fruit.

Work along some of these lines of investigation has been carried out over the past four years and the following account summarises the results obtained. These investigations will be continued further but, owing to the growing interest among orchardists, it was decided to indicate the lines along which these researches were being made and the indications obtained so far.



Fig. 1.—Mediterranean Fruit Fly (greatly enlarged). 1, Female; 2, Male (note tiny club-like appendages on head of male). (After Silvestri.)

The main lines of investigation were:—

Cage Baiting Trials.

Field Baiting Trials.

Soil Treatments.

Treatment of infested fruits to prevent breeding and emergence of the flies.

CAGE BAITING TRIALS.

Exploratory tests were conducted during 1946-47 season to determine the effectiveness of both D.D.T. and benzene-hexachloride in sugar bait when compared with sodium fluosilicate (Na_2SiF_6). Heavy concentrations of these insecticides (0.156 per cent. gamma isomer B.H.C. and 0.156 per cent. p.p. isomer of D.D.T.) were prepared in sugar baits and compared with sodium fluosilicate bait (containing 0.156 per cent. Na_2SiF_6). Fifty per cent. of the flies baited with B.H.C. bait were incapacitated in less than four hours, as compared with 30 to 50 hours in the case of sodium fluosilicate and 70 to 90 hours in the case of D.D.T.

A series of cage baiting trials were then carried out using various concentrations of insecticides under varying test conditions and the following results were obtained:—

D.D.T. (Dichloro-diphenyl-trichloroethane).

Where no other source of food was provided, D.D.T. at a concentration of 0.156 per cent. p.p. isomer was much slower in its action than the sodium fluosilicate bait normally recommended. The time taken to knockdown 50 per cent. of the caged flies was approximately 48 hours in the case of D.D.T., as compared with 21 hours in the case of sodium fluosilicate. Where alternate food was provided for the flies a similar result was obtained—D.D.T. being much slower in its action than sodium fluosilicate. These results indicated that further work with D.D.T. in baits was not warranted.

B.H.C. (Benzene-hexachloride).

The effect of benzene-hexachloride on fruit flies caused them to fall to the bottom of the cage where they walked about uncertainly or essayed short flights. At this stage they were quiet and did not move readily. Then followed a short period of intense activity during which the flies buzzed vigorously about the floor of the cage on their backs, using their wings to propel them; then they lay on their backs and continued to twitch their legs for some considerable time even up to two days before they could be considered dead. For all practical purposes they were incapacitated when they reached the stage of lying on their backs with legs twitching and as this stage was fairly well defined it was used to record knockdown in this series of cage trials.

Concentrations of B.H.C. ranging from 0.156 per cent. gamma isomer to 0.025 per cent. gamma isomer were tested in this series of preliminary trials.

At all concentrations B.H.C. was very rapid in its knockdown effect and a knockdown time 50 per cent. of less than five hours was recorded for all concentrations. In comparison with a knockdown time 50 per cent. of 21-24 hours for sodium fluosilicate, this insecticide was obviously very effective in obtaining a rapid knockdown and subsequent kill.

The presence of an alternate food supply did not affect the rate of knockdown.

A comparison was made of the effects of introducing flies into cages which had been baited 6 and 12 days previously.



LIFE HISTORY
OF
MEDITERRANEAN
FRUIT FLY
Ceratitis capitata Wied.

Fig. 2.—Life cycle of the Mediterranean fruit fly. A. A fly pierces the skin and lays a group of three to 10 eggs. B. The eggs lie in a pocket beneath the skin. C. The eggs hatch and the young maggots burrow inwards. D. Advanced stage of feeding, showing internal breakdown of the fruit. There may be a discoloured patch around the egg-laying puncture, but otherwise the fruit appears sound externally. E. The fruit may fall before the maggots emerge, or may remain on the tree. In either case, the maggots cut their way out, droo to the ground, and transform to pupae in the topsoil. F. After a period of 10 to 20 days in summer, adult flies emerge from pupae in the soil. They return to the shelter of the foliage, in which they live for some days before beginning to lay eggs.

(After D. C. Swan.)

There appeared to be a decline in effectiveness of the bait after 12 days but even after 12 days the lowest concentration of B.H.C. was just as rapid in its effect as freshly applied sodium fluosilicate.

An unsweetened water suspension of 0.1 per cent gamma isomer B.H.C. used in the same manner as the baits gave a slower rate of knockdown than the baits containing B.H.C. but was somewhat more rapid in its effect than the sodium fluosilicate bait, the comparative figures being for knockdown time 50 per cent. sodium fluosilicate 21 hours, various concentrations of B.H.C. in baits under five hours and for unsweetened B.H.C., 17 hours.

Using a stricter cage technique various baits containing 0.1 per cent., 0.05 per cent. and 0.01 per cent. gamma isomer were tested. There appeared to be an increase in the rate of knockdown with increasing concentrations, and of the baits tested that containing 0.1 per cent gamma isomer appeared to be most rapid.

Tests were carried out to determine the attractiveness of the bait to fruit flies but no difference in attractiveness could be demonstrated between B.H.C. baits and sodium fluosilicate bait.

"Hexone" (Hexaethyl Tetraphosphate).

A single preliminary trial was conducted using hexone at the concentration of 1 oz. in four gallons of water and 2½ lb. of sugar. This bait did not appear to be so rapid in its action as benzene-hexachloride.

FIELD BAITING TRIALS.

Baiting of Individual Trees.

Following the early successes with B.H.C. in cage trials, baits were applied to a number of fruit trees in the field.

At an orchard in Bedfordale two Keiffer pear trees situated close together in a block of Keiffer pears were selected and one was baited with sodium fluosilicate bait whilst the other was baited with 0.05 per cent. gamma isomer B.H.C. bait. The trees were baited at weekly intervals and the fruit was left on these two trees for two weeks after the main crop had been picked. The fruit was then held in the shed for 1 week and examined for fruit fly strike. From the sodium fluosilicate baited tree 31 fruits were fly struck out of a total of 202 fruits picked, and from the benzene-hexachloride baited tree 95 fruits were fly struck out of a total of 398 fruits picked. It is clear from these figures that neither bait will give complete protection from fruit fly strike.

A single Valencia orange tree in a Mt. Lawley garden was heavily infested with fruit fly and advantage was taken of the opportunity of examining the knockdown of the flies after a bait containing 0.05 per cent. gamma isomer was applied.

It appears that over 50 per cent. of the flies were killed by the bait within 24 hours of applying it. On the 20/7/48, numerous flies again appeared in the trees and another application of bait was made with the following results:—

After 1 day—29 dead flies.

After 2 days—28 dead flies.

After 3 days—23 dead flies.

No further flies were observed in the trees after the third day.

Field Experiment on Navel Oranges.

A large scale field baiting experiment was carried out on navel orange trees during 1949. The experiment consisted of four baiting experiments replicated five times. The following treatments were applied:—

1. Control—Standard sodium fluosilicate bait consisting of a 6.25 per cent. sugar solution and containing 0.167 per cent. sodium fluosilicate.
2. A bait consisting of a 6.25 per cent. sugar solution containing 0.01 per cent. gamma isomer of benzene-hexachloride.
3. A bait consisting of a 6.25 per cent. sugar solution containing 0.05 per cent. gamma isomer of benzene-hexachloride.
4. A bait consisting of a 6.25 per cent. sugar solution containing 0.03 per cent. active ingredient of E.605.

The number of strikes per 100 fruits picked was calculated and the means of the various treatments were:—

Treatment 1.—4.6

Treatment 2.—19.9

Treatment 3.—1.6

Treatment 4.—6.1

Thus treatments 1, 3 and 4 were apparently superior to treatment 2.

*E.605 bait (treatment 4), which had given good results against the Queensland fruit fly (A. H. Friend, Agric. Gaz. N.S.W. Vol. LX. Pt. 1, p. 35), was shown to be just as efficient as the standard Sodium fluosilicate spray but not superior to it in its control of the fruit fly.

Distribution of Strikes in Orange Trees.

During the examination of the fruit in the previous experiment, a great deal of work was involved in examining all fruit from each sample tree. Observations of fly activity indicated that fly strike may be more frequent in some parts of the tree and on one of the experimental blocks the fruit was removed from each tree in quadrants, which had northern, western, eastern and southern aspects.

The results indicated that strikes in individual trees are not evenly distributed and that any sub-sampling of the fruits would be prone to error unless carefully related to the aspect of the tree from which they were taken.

Fruit Fly Populations.

The baiting trials carried out so far show an extreme variability in the fruit fly population in the field.

At Parkerville an orchard was chosen for experimentation for the reason that it had been severely affected by fruit fly the previous season and because properties adjacent to it on two sides had suffered gross infestations during the current fruit season. The resultant infestation on the experimental area, however, was practically negligible and useless from the point of view of experimentation.

This condition was of considerable interest nevertheless in demonstrating the results which the normal control programme can achieve if conscientiously applied. The orchardist paid particular attention to orchard sanitation and commenced a regular system of sodium fluosilicate baiting early in the season.

In the experiment on navel oranges two of the blocks showed a very low fly population, even though they were separated by a roadway only from blocks showing a relatively heavy population.

This variation was shown in even greater detail by the counts of fly strike from individual trees in the experimental area. Adjoining trees in the same treatment were found to vary greatly in the total number of strikes, e.g. 15 and 266.

*E 605 was supplied by Henry York & Co., Sydney, for the purposes of the experiment.



Fig. 3.—An orange showing numerous fruit fly punctures in the skin.

It is obvious that with such great variability the value of baits can best be determined by means of a large scale statistically-laid-out experiments with adequate replication.

SOIL TREATMENTS.

Toxicity of D.D.T. and B.H.C. to Adult Flies.

The toxicity of both insecticides to adult fruit flies was shown by exposing them to surfaces covered with a deposit of either B.H.C. or D.D.T. The flies were incapacitated more rapidly by B.H.C. than by D.D.T. but both insecticides were toxic to them.

Effect on Flies emerging from the soil.

Having in mind the possibility of treating the surface of the soil to contact flies emerging from pupae in the soil, a laboratory experiment was carried out using D.D.T. and B.H.C.

D.D.T. dusts were used at the rates of $\frac{1}{2}$ lb. p.p. D.D.T. per acre and 2 lb. p.p. D.D.T. per acre.

B.H.C. dusts were used at the rates of 0.13 lb. gamma isomer B.H.C., 0.52 lb gamma isomer B.H.C. and 2.08 lb. gamma isomer B.H.C. per acre.

D.D.T. sprays were used at the rates of 1 lb. p.p. D.D.T. and 10 lb. p.p. D.D.T. per acre.

B.H.C. sprays were used at the rates of 1 lb. gamma isomer B.H.C. and 10 lb. gamma isomer B.H.C. per acre.

Flies commenced emerging three days after the application of the treatments.

All of the B.H.C. treatments were effective in killing flies soon after they emerged—in many cases before they had sufficient time to spread their wings. None of the flies emerging in cages treated with B.H.C. lived for longer than four to six hours.

None of the D.D.T. treatments were effective in obtaining a similar result.

A field trial was conducted using B.H.C. dust at the rate of 0.26 lb. gamma isomer per acre. This trial failed to show any toxic effect in the field to flies emerging from pupae in the soil. In one treatment the flies emerging a few days after the application of treatments showed a reduction in the length of life, having an average length of life of 7-8 days as compared with from 23-30 days for the flies in the remaining cages. This was considered to be due to the effects of a weak fumigation exerted by the B.H.C. and subsequent trials were carried out in the laboratory to show the fumigation effects in the lamp glass cages originally used.

Pupae were placed on a fly wire platform suspended in a lamp glass cage above a petri dish containing a mixture of sand and B.H.C. dust as shown in Figure 4.

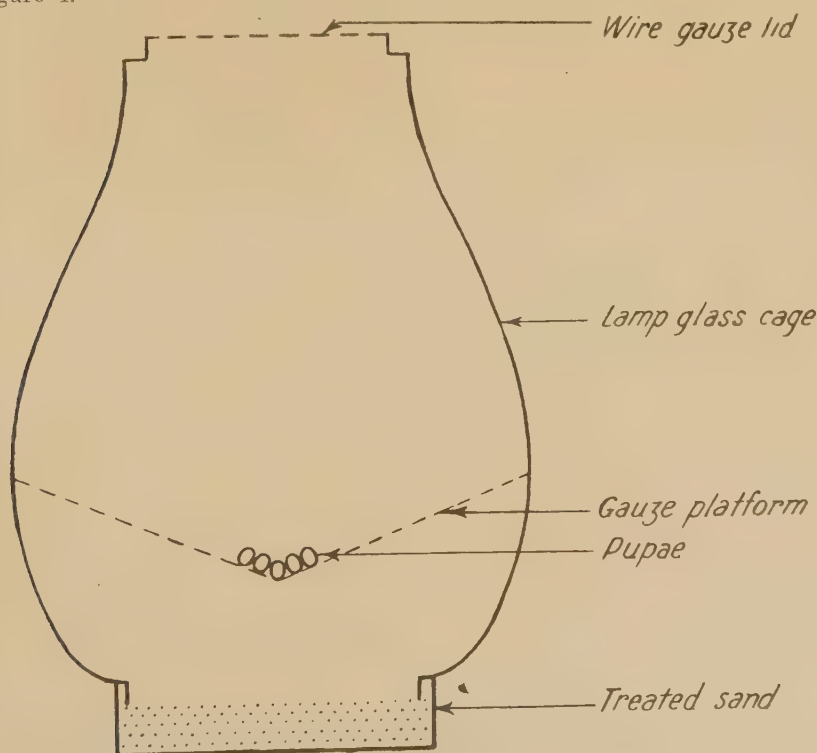


Fig. 4.—Lamp glass cage used for testing effects of fumigation on fruit flies emerging from pupae.

All the flies which emerged in the control cage remained alive but those emerging in the cage over the B.H.C. treated sand failed to survive longer than four hours.

A similar effect was demonstrated in this type of cage by covering pupae in the centre of the petri dish with clean sand confined by a fly wire cone which was surrounded by treated sand. This arrangement is shown in Figure 5, below:—

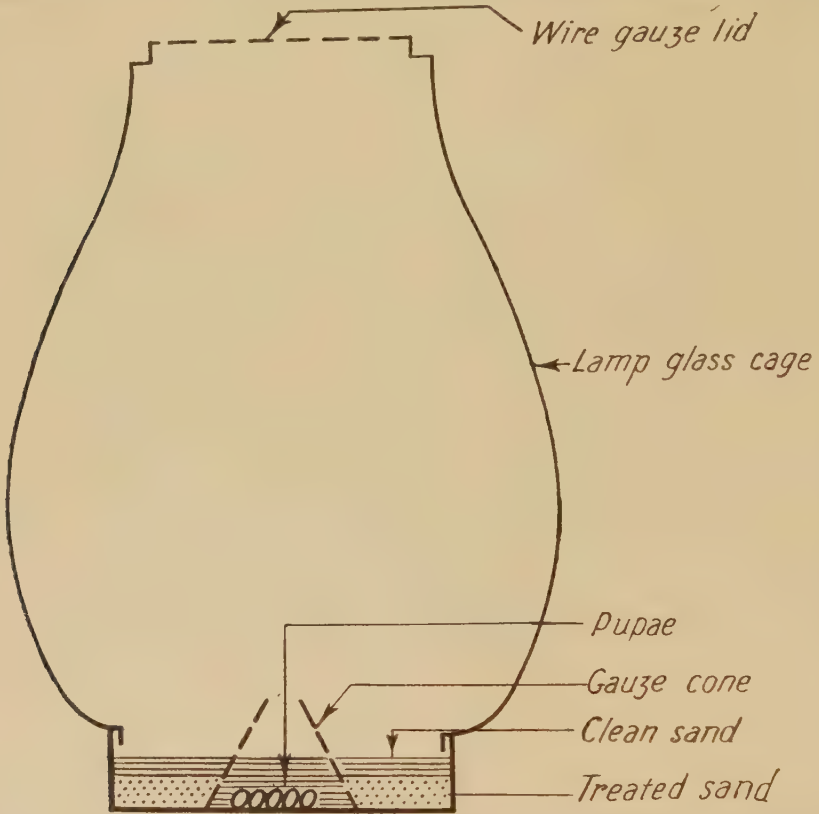


Fig. 5.—Method of rearing flies from pupae in clean sand but surrounded by treated sand under a lamp glass cage.

Again the flies in the control cages lived for periods of more than one week whilst those in the cages receiving insecticidal treatment failed to live for periods longer than one day.

The dusts used in these experiments had been mixed with sand for periods of $3\frac{1}{2}$ weeks and 6 weeks prior to the experiment and had been exposed in the open over this period. It was obvious that they exerted a strong fumigant effect after this lapse of time.

Orchard Field Trials.

A small field trial was conducted on an orchard at Kelmseott under apricot trees which had shed some infested fruit. Areas were given light and heavy dustings (approximately 1 cwt./acre and 3 cwt./acre respectively) of a dust containing 0.26 per cent. gamma isomer benzene-hexachloride, and cages placed over these areas.

The light dusting treatment was not sufficiently effective in controlling emerging flies and whilst the heavy dusting appeared to have some effect in controlling flies, it was not wholly effective.

Further trials are necessary to show a dust concentration suitable for this purpose.

Effect on larvae entering the soil.

The effects of both D.D.T. and B.H.C. on the larvae of the fruit fly were determined by means of a preliminary trial.

One part by volume of a D.D.T. dust containing 2 per cent. p.p. isomer D.D.T. was mixed with three parts by volume of clean sand and one part by volume of B.H.C. dust containing 0.26 per cent. gamma isomer, B.H.C., was mixed with three parts by volume of sand.

Mature fruit fly larvae were placed on these mixtures both moist and dry to allow them to pupate.

In the D.D.T. treated sand the larvae pupated and the flies emerged and subsequently died as a result of contact with the D.D.T. on the surface of the sand.

In the B.H.C. treated sand all the larvae failed to pupate and the dead larvae were recovered from the sand.

It was clear that B.H.C. is toxic to the maggots of the fruit fly whilst D.D.T. is not.

The possibility of the larvae being affected by fumigation from the B.H.C. was tested by placing larvae in a waxed container with a fine wire mesh base and suspending them over a heavy concentration of B.H.C. in a lamp glass cage. The larvae pupated normally and were transferred to a breeding cage where they developed into normal fruit flies. It was clear that the larvae were not affected by fumigation from B.H.C.

A laboratory trial was conducted to determine the effect of different concentrations of B.H.C. incorporated in the soil on fully developed larvae. Sand was mixed with a dust containing 1.3 per cent. gamma isomer B.H.C. in the following concentrations and left exposed to summer weather:—

1. 2.43 lb. gamma isomer B.H.C./acre to a depth of $\frac{1}{2}$ inch exposed $4\frac{1}{2}$ months.
2. 1.21 lb. gamma isomer B.H.C./acre to a depth of $\frac{1}{2}$ inch exposed $4\frac{1}{2}$ months.
3. 0.24 lb. gamma isomer B.H.C./acre to a depth of $\frac{1}{2}$ inch exposed $4\frac{1}{2}$ months.
4. 2.43 lb. gamma isomer B.H.C./acre to a depth of $\frac{1}{2}$ inch exposed four months.
5. 1.21 lb. gamma isomer B.H.C./acre to a depth of $\frac{1}{2}$ inch exposed four months.
6. 0.24 lb. gamma isomer B.H.C./acre to a depth of $\frac{1}{2}$ inch exposed four months.
7. Control.—Clean sand.

The results of this trial indicated that all six B.H.C. treatments were superior to the control in their toxic effect on maggots. In treatments 1 and 4 no flies were formed. Some of the maggots succeeded in pupating but the pupae were distorted and in many cases obviously dead a few days after they were formed. From treatments 2 and 3 one fly in each case succeeded in completing its development and in treatments 5 and 6 two flies in each case succeeded in completing their development, but died within a few hours of emergence. This trial was repeated with two replications of treatments and all treatments were superior to the control and again the dead maggots and misshapen pupae were recovered from the soil.

It must be pointed out that this trial has been carried out under laboratory conditions only and suitable soil dressing must be demonstrated under field conditions before recommendations can be made.

DISPOSAL OF INFESTED FRUITS.

Burying Infested Fruit.

The existing regulations concerning the disposal of infested fruit insist that these be disposed of by burning or boiling. The disposal of large quantities of fruit by burning is usually a difficult operation and even destruction by boiling is often found tedious by orchardists. This results in some laxity in destroying fruit fly infested fruits on individual orchards.

An attempt was made to devise a simpler method of disposing of this fruit and tests were carried out with pits which had been treated with B.H.C.

Six pits approximately one foot square and 18in. deep were dug in sandy soil. All except a control were treated by heavily spraying the bottom and sides of them with a spray containing 0.5 per cent. gamma isomer B.H.C. A six-inch layer of fruit fly infested apricots was placed in the bottom of the pit and various treatments with B.H.C. were used on the surface of the fruit. A few inches of sand were then placed on top of the fruit layer. A paper cone was fitted to the top of the pit to encourage emerging flies to come to the surface above the pit and the whole enclosed in a flywire cage. Provision was made for feeding the flies by means of a cotton wool plug. This arrangement is shown diagrammatically in Fig. 6.

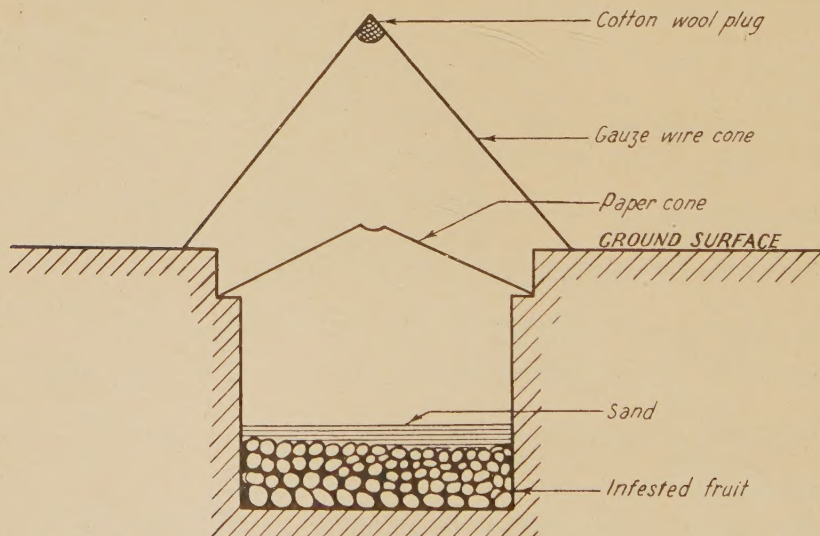


Fig. 6.—Diagram of pit for testing the effect of Gammexane on infested fruit.

The following treatments were used:—

1. Control—no insecticidal treatment.
2. Heavy initial spraying with 0.5 per cent. gamma isomer B.H.C. followed by heavy spraying after the fruit had been placed in the pit.
3. Heavy initial spraying with 0.5 per cent. gamma isomer B.H.C. followed by light spraying with the same spray after the fruit had been placed in the pit.

4. Heavy initial spraying with 0.5 per cent. gamma isomer B.H.C. followed by heavy dusting with 10 per cent. B.H.C. powder containing 1.3 per cent. gamma isomer after the fruit had been placed in the pit.
5. Heavy initial spraying with 0.5 per cent. gamma isomer B.H.C. followed by light dusting with 10 per cent. B.H.C. dust containing 1.3 gamma isomer after the fruit had been placed in the pit.
6. Same as 4, except that subsequent heavy dustings given at weekly intervals.

Approximately 200 flies emerged from the control pit but none emerged from any of the treatments.

When the pits were opened no adult flies could be observed in any pit other than the control.

A small cage of adult flies was lowered into the pit on treatment 4 at 4 p.m. and all were dead next morning. There appeared to be a strong fumigatory effect in the pit.

A similar trial was conducted with fruit fly infested figs.

Two pits 1 ft. square were dug and one of them was dusted on the bottom and sides with a dust containing 1.3 per cent. gamma isomer B.H.C. using 2 oz. of dust. A layer of infested figs was placed in the pit and the surface of the fruit again dusted.

In the control pit a similar layer of infested fruit was placed in the pit but no insecticidal treatment was applied. Approximately 100 flies emerged from the control pit but none emerged from the treated pit. It is clear that B.H.C. is a useful insecticide for this purpose, but more work is required to determine minimum treatments which will ensure the destruction of all larvae infesting the fruit and will be toxic to flies emerging from pupae which may have formed in the body of the fruit layer.

Steeping Infested Fruits.

During the picking season orchardists are usually fully engaged in harvesting their crops and have little time to spare for the destruction of fruit culled because of fruit fly infestation. A practice which has grown up is to immerse these infested fruits in water for a few days.

Several trials were carried out using various concentrations of benzene-hexachloride in the water in which fruits were steeped. The fruits were steeped for varying periods of time. They were removed from the steeping drums and allowed to drain before being placed on pure sand to pupate. No advantage could be demonstrated from including benzene-hexachloride in the steeping liquid in its effect on the maggots inside the fruit.

A very few pupae were formed but flies emerged from them after seven days steeping both in water alone and in water containing B.H.C.

However, if fruits steeped in water containing B.H.C. were emptied into a pit a condition would be set up similar to that described for dumping fruits in treated pits and would be expected to prevent further breeding of fruit flies.

GENERAL OBSERVATIONS.

The difficulties in obtaining valid results from trials with this pest were apparent.

Much of the work carried out has been conducted under laboratory conditions and must be demonstrated in the field before any recommendations as to its use can be made. Earlier successes in the laboratory have not been confirmed under field conditions because of the operation of unknown factors.

In respect to field trials the extreme variability of the fly population in different sections of our orchards and indeed between adjoining trees has rendered the task of field experimentation very difficult, requiring very carefully planned trials. It is obvious that single trees do not provide a reliable guide under field conditions of the efficiency of treatments. Furthermore, these results indicate the complete impossibility of individual orchardists being able to draw sound conclusions from casual observations and tests carried out on their own properties.

The suggestion has been made by various growers that sodium fluosilicate is becoming less effective against the fruit fly due to the development of resistant strains of flies. There was no indication from either cage experiments or field trials to support this contention.

The results given throughout indicate that B.H.C. is a very promising insecticide for the control of fruit fly when used in baits, as a soil dressing beneath trees and as a means of preventing the maggots in infested fruits developing fully. It must be realised, however, that many of these results must be established under field conditions before they can be considered valid and that further work is required before definite recommendations can be made.

BOOK REVIEW.

SHEEP MANAGEMENT AND DISEASES.

By H. G. BELSCHNER, D.V.S.C. H.D.A.

THIS publication should prove of inestimable value to the sheepman and student alike. It may also be commended to the Veterinarian as a book of reference for inclusion on his library shelves.

The book is presented in two parts, the first of which deals with sheep management and covers an extremely wide field. It contains a wealth of information upon such subjects as the breeds of sheep, breeding for wool and meat production, feeding under both normal and drought conditions, water supplies, sheep classing, dentition and age marking, lamb marking, shearing, crutching, branding, the construction of shearing sheds and yards, and the classing, handling, and marketing of the wool clip.

Chapters are devoted to blowfly strike, its control and treatment and to sheep dipping, spraying and jetting. In the section dealing with breeding, subjects such as hand service, progeny testing, artificial insemination, fertility and the keeping of records are discussed.

Part II is concerned with the diseases of sheep. After furnishing information in the initial chapters relating to the anatomy and physiology of the sheep and the methods to be adopted for the investigation and diagnosis of sickness or mortality, the author goes on to describe the infectious, non-infectious and parasitic diseases of sheep as they occur under Australian conditions placing due emphasis upon prevention and control. Chapters dealing with poisoning in sheep, the treatment of wounds and fractures, and the usage and dosage of common drugs have also been included. The book is profusely illustrated and the material is presented in simple non-technical language which should readily be understood by the layman.

"Sheep Breeding and Management" may be recommended not only to the sheepman and student but to all those who are concerned either directly or indirectly with the sheep and wool industry.

"Sheep Management and Diseases" by H. G. Belschner, D.V.S.C. H.D.A. Price 75s. Our copy from the publishers Angus and Robertson.